3.0 Waste Management Unit Data

The 3MRA modeling system was designed to estimate potential risks from the long-term management of hazardous and nonhazardous waste by waste management facilities. The representative national data set focuses on Resource Conservation and Recovery Act (RCRA) Subtitle D nonhazardous industrial waste management units (WMUs).

The 3MRA modeling system includes 17 media-specific pollutant release, fate, transport, exposure, and risk modules. WMU input data are used explicitly by seven of these modules: the five source modules, the Air Module, and the Vadose Zone module.[1] These WMU inputs describe the size and operation of the five WMU types that can be modeling by the 3MRA modeling system: surface impoundments, aerated tanks, landfills, waste piles, and land application units (LAUs). This section describes the derivation and use of values for the WMU data for each of these WMU types. Data sources are described along with data collection methodologies.

3.1 Parameters Collected

Table 3-1 presents the WMU model inputs as required by the source and media modules. Three parameterization approaches were used for WMU inputs: site-specific, site-based and national. Site-specific data on WMU area, capacity, and waste loading rates were obtained from the Industrial D Screening Survey (Westat, 1987). Size-related WMU variables which were derived from these Industrial D data, are referred to as site-based data in this document. All other WMU inputs were developed on a national basis as either distributions or fixed values, depending on potential variability and model sensitivity.

3.2 Data Sources

The following documents are the primary data sources for the WMU data used for the representative national data set:

- *Surface impoundments, landfills, waste piles, and LAUs – Screening Survey of Industrial Subtitle D Establishments. Draft Final Report.* (Westat, 1987).

- *Aerated tanks – 1986 National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities (TSDR) Database*. (U.S. EPA, 1987).

[1]WMU area also impacts site layout data by defining the area of interest (AOI) and, hence, implicitly affects other modules as well.

Table 3-1. WMU Inputs by Module

Model Inputs	Source Modules					Media Modules`	
	Aerated Tank	Land Application Unit	Landfill	Surface Impoundment	Waste Pile	Air	Vadose Zone
Site-Specific							
area of source		●	●	●	●	●	
Setting ID (SrcType+SiteID)						●	
waste loading rate (dry)					●		
WMU type (AT, SI, LAU, WP, or LF)	●	●	●	●	●	●	●
Site-Based							
depth of WMU (0 for AT, WP)		●	●	●			●
distance vehicle travels on active WMU surface		●	●		●		
fraction of SI occupied by sediments				●			
fraction organic carbon (cover soil)			●				
fraction surface area turbulent				●			
frequency of surface disturbance per month (active WMU)		●	●				
height (WP)					●		
impellers/aerators (number)				●			
impellers/aerators (total power)				●			
number of cultivations per application		●					
saturated hydraulic conductivity (LF cover soil)			●				
saturated water content (cover soil, total porosity)			●				
SCS curve number (WMU)		●			●		
soil moisture coefficient b (LF cover soil)			●				
source height						●	
spreading/compacting operations per day			●		●		
vehicle weight (mean)		●	●		●		
vehicles/day (mean annual)		●	●		●		
volumetric influent flow rate				●			
waste applications per year		●					
waste loading rate (dry)			●				
wet waste application rate		●					
wheels per vehicle (mean)		●	●		●		
National Tank Data (Correlated)							
area of source	●						
depth (liquid)	●						
fraction surface area-turbulent	●						

(continued)

Table 3-1. (continued)

	Source Modules					Media Modules`	
Model Inputs	**Aerated Tank**	**Land Application Unit**	**Landfill**	**Surface Impoundment**	**Waste Pile**	**Air**	**Vadose Zone**
impellers/aerators (number)	●						
impellers/aerators (total power)	●						
volumetric flow rate (tank)	●						
National							
biologically active solids/total solids (ratio)	●			●			
biomass yield	●			●			
depth (tilling, LAU)		●					
digestion (sediments)	●			●			
dust suppression control efficiency		●	●		●		
economic life of AT/SI	●			●			
fraction of unit occupied by sediments (max.)	●			●			
fraction vegetative cover (inactive WMU)		●	●				
impeller diameter	●			●			
impeller speed	●			●			
number of economic lifetimes (AT, SI)	●			●			
number of waste layers in a cell			●				
operating life (LAU, WP)		●			●		
optional soil cover thickness			●				
oxygen transfer correction factor	●			●			
oxygen transfer factor	●			●			
roughness height (inactive WMU)		●	●				
roughness ratio (LF waste zone surface)			●				
roughness ratio (till zone surface)		●					
saturated hydraulic conductivity (sediment layer)				●			
thickness of liner (or subsoil zone)			●				
USLE cover factor (WMU)		●			●		
USLE erosion control factor (WMU)		●			●		
vehicle speed (mean)		●	●		●		0

AT = aerated tank; LAU = land application unit; LF = landfill; SI = surface impoundment; USLE = universal soil loss equation; WMU = waste management unit; WP = waste pile.

Other data sources such as literature, site visits, and vendor information were used to supplement these sources as necessary. Table 3-2 lists the inputs for each model and includes the source code, units, parameterization (i.e., site-specific, site-based, or national), and data source for each input.

Table 3-2. WMU Data Sources

Model Input	Code	Units	Parameterization	Data Source
Landfill				
area of source	SrcArea	m^2	site-specific	Ind. D Screening Survey (Westat, 1987)
depth of source	SrcDepth	m	site-based	derived from Ind. D
distance vehicle travels on active LF cell surface	mt	m	site-based	derived from Ind. D
dust suppression control efficiency	effdust	unitless	national	U.S. EPA (1989)
fraction organic carbon (cover soil)	focC	mass fraction	site-specific	USSOILS (Schwarz and Alexander, 1995)
fraction vegetative cover (inactive LF cell)	veg	fraction	national	professional judgment
frequency of surface disturbance per month (active LF cell)	fd	1/mo	site-based	derived from Ind. D
number of waste layers in a cell	Nly	unitless	site-based	derived from Ind. D
optional soil cover thickness	zC	m	national	professional judgment
roughness height (inactive LF cell)	zruf	cm	national	U.S. EPA (1989)
roughness ratio (LF waste zone surface)	Lc	unitless	national	U.S. EPA (1989)
saturated hydraulic conductivity (LF cover soil)	KsatC	cm/h	site-specific	CONUS (Miller and White, 1998); Carsel and Parrish (1988)
saturated water content (cover soil, total porosity)	WCS_C	volume fraction	site-specific	CONUS (Miller and White, 1998); Carsel and Parrish (1988)
soil moisture coefficient b (LF cover soil)	SMbC	unitless	site-specific	CONUS (Miller and White, 1998); Carsel and Parrish (1988)
spreading/compacting operations per day	Nop	1/d	site-based	derived from Ind. D
thickness of liner (or subsoil zone)	zS	m	national	professional judgment
vehicle speed (mean)	vs	km/h	national	Overcash and Pal (1979)
vehicle weight (mean)	vw	Mg	site-based	derived from Ind. D
vehicles/day (mean annual)	nv	1/d	site-based	derived from Ind. D
waste loading rate (dry)	load	Mg/yr	site-based	derived from Ind. D
waste zone thickness	zW	m	site-based	derived from Ind. D
wheels per vehicle (mean)	nw	unitless	site-based	derived from Ind. D
WMU type (specified LF)	SrcType	unitless	site-specific	Ind. D Screening Survey (Westat, 1987)
Waste pile				
area of source	SrcArea	m^2	site-specific	Ind. D Screening Survey (Westat, 1987)
distance vehicle travels on WP surface	mt	m	site-based	derived from Ind. D

(continued)

Table 3-2. (continued)

Model Input	Code	Units	Parameterization	Data Source
dust suppression control efficiency	effdust	unitless	national	U.S. EPA (1989)
height of WP above grade	zZ1WMU	m	site-based	derived from Ind. D
operating life	CutOffYr	yr	national	professional judgment
SCS curve number (WMU)	CNwmu	unitless	site-based	derived from Ind. D
spreading/compacting operations per day	Nop	1/d	site-based	derived from Ind. D
USLE cover factor (WMU)	Cwmu	unitless	national	Wanielista and Yousef (1993)
USLE erosion control factor (WMU)	Pwmu	unitless	national	Wanielista and Yousef (1993)
vehicle speed (mean)	vs	km/h	national	Overcash and Pal (1979)
vehicle weight (mean)	vw	Mg	site-based	derived from Ind. D
vehicles/day (mean annual)	nv	1/d	site-based	derived from Ind. D
waste loading rate (dry)	load	Mg/yr	site-specific	Ind. D Screening Survey (Westat, 1987)
wheels per vehicle (mean)	nw	unitless	site-based	derived from Ind D
WMU type (specified WP)	SrcType	unitless	site-specific	Ind. D Screening Survey (Westat, 1987)
Land Application Unit				
area of source	SrcArea	m^2	site-specific	Ind. D Screening Survey (Westat, 1987)
depth of tilling	zZ1WMU	m	national	literature
depth of source	SrcDepth	m	national	= tilling depth
distance vehicle travels on LAU surface	mt	m	site-based	derived from Ind. D
dust suppression control efficiency	effdust	unitless	national	U.S. EPA (1989)
fraction vegetative cover	veg	fraction	national	professional judgment
frequency of surface disturbance per month (active LAU)	fd	1/mo	site-based	derived from Ind. D
number of cultivations per application	fcult	unitless	site-based	derived from Ind. D
operating life	CutOffYr	yr	national	professional judgment
roughness height	zruf	cm	national	U.S. EPA (1989)
roughness ratio (till zone surface)	Lc	unitless	national	U.S. EPA (1989)
SCS curve number (WMU)	CNwmu	unitless	site-based	derived from Ind. D
USLE cover factor (WMU)	Cwmu	unitless	national	Wanielista and Yousef (1993)
USLE erosion control factor (WMU)	Pwmu	unitless	national	Wanielista and Yousef (1993)
vehicle speed (mean)	vs	km/h	national	Overcash and Pal (1979)

(continued)

Table 3-2. (continued)

Model Input	Code	Units	Parameterization	Data Source
vehicle weight (mean)	vw	Mg	site-based	derived from Ind. D
vehicles/day (mean annual)	nv	1/d	site-based	derived from Ind. D
waste applications per year	Nappl	1/yr	site-based	derived from Ind. D
wet waste application rate	Rappl	Mg/m^2-yr	site-based	derived from Ind. D
wheels per vehicle (mean)	nw	unitless	site-based	derived from Ind. D
WMU type (specified LAU)	SrcType	unitless	site-specific	Ind. D Screening Survey (Westat, 1987)
Surface Impoundment				
area of source	SrcArea	m^2	site-specific	Ind. D Screening Survey (Westat, 1987)
biologically active solids/total solids (ratio)	kba1	unitless	national	Tchobanoglous (1979)
biomass yield	bio_yield	g/g	national	Tchobanoglous (1979)
depth of source	SrcDepth	m	site-specific	Ind. D Screening Survey (Westat, 1987)
depth of WMU	d_wmu	m	site-based	derived from Ind. D
digestion (sediments)	k_dec	1/s	national	Tchobanoglous (1979)
economic life of AT/SI	EconLife	yr	national	professional judgment
fraction of SI occupied by sediments (max.)	d_setpt	fraction	site-based	derived from Ind. D
fraction surface area-turbulent	F_aer	fraction	site-based	derived from Ind. D
impeller diameter	d_imp	cm	national	U.S. EPA (1990)
impeller speed	w_imp	rad/s	national	U.S. EPA (1990)
impellers/aerators (number)	n_imp	unitless	site-based	derived from Ind. D
impellers/aerators (total power)	Powr	hp	site-based	derived from Ind. D
number of economic lifetimes	NumEcon	unitless	national	professional judgment
oxygen transfer correction factor	O2eff	unitless	national	Tchobanoglous (1979)
oxygen transfer factor	J	lb O_2/h-hp	national	Tchobanoglous (1979)
saturated hydraulic conductivity (sediment layer)	hydc_sed	m/s	national	professional judgment
volumetric influent flow rate	Q_wmu	m3/s	site-based	derived from Ind. D
WMU type (specified SI)	SrcType	unitless	site-specific	Ind. D Screening Survey (Westat, 1987)
Aerated Tank				
area of source	SrcArea	m^2	national_correlated	derived from TSDR Survey
biologically active solids/total solids (ratio)	kba1	unitless	national	Tchobanoglous (1979)
biomass yield	bio_yield	g/g	national	Tchobanoglous (1979)
depth (liquid)	d_wmu	m	national_correlated	derived from TSDR Survey

(continued)

Table 3-2. (continued)

Model Input	Code	Units	Parameterization	Data Source
digestion (sediments)	k_dec	1/s	national	Tchobanoglous (1979)
economic life of AT/SI	EconLife	yr	national	professional judgment
fraction of tank occupied by sediments (max.)	d_setpt	fraction	national	professional judgment
fraction surface area-turbulent	F_aer	fraction	national_correlated	derived from TSDR Survey
impeller diameter	d_imp	cm	national	U.S. EPA (1990)
impeller speed	w_imp	rad/s	national	U.S. EPA (1990)
impellers/aerators (number)	n_imp	unitless	national_correlated	API/CMA/SOCMA (1998)
impellers/aerators (total power)	Powr	hp	national_correlated	professional judgment
number of economic lifetimes	NumEcon	unitless	national	professional judgment
oxygen transfer correction factor	O2eff	unitless	national	Tchobanoglous (1979)
oxygen transfer factor	J	lb O_2/h-hp	national	Tchobanoglous (1979)
volumetric flow rate (tank)	Q_wmu	m^3/s	national_correlated	TSDR Survey (U.S. EPA, 1987)
WMU type (specified AT)	SrcType	unitless	site-specific	specified for sites w/SI
Air				
area of source	SrcArea	m^2	site-specific	Ind. D Screening Survey (Westat, 1987)
source height	SHight	m	site-based	derived from Ind. D
SettingID (SrcType+SiteID)	SettingID	unitless	site-specific	Ind. D Screening Survey (Westat, 1987)
WMU type (AT, SI, LAU, WP, or LF)	SrcType	unitless	site-specific	Ind. D Screening Survey (Westat, 1987)
Vadose Zone				
depth of source (0 for AT, WP)	SrcDepth	m	site-based	derived from Ind. D
WMU type (AT, SI, LAU, WP, or LF)	SrcType	unitless	site-specific	Ind. D Screening Survey (Westat, 1987)

AT = aerated tank; LAU = land application unit; LF = landfill; SI = surface impoundment; USLE = universal soil loss equation; WMU = waste management unit; WP = waste pile

3.2.1 Industrial D Screening Survey

The primary source of data used to characterize waste sources is the 1985 *Screening Survey of Industrial Subtitle D Establishments*, referred to as the Industrial D Screening Survey or Ind D (Westat, 1987). This survey was designed to collect information about nonhazardous (RCRA Subtitle D) waste management practices at industrial facilities across the United States. Data were gathered for the following land-based WMU types: surface impoundments, landfills, waste piles, and LAUs. The representative national data set used the facility address, dimensions of the WMUs, and annual waste volumes for the WMUs.

The Industrial D Screening Survey collected information on land-based Ind D waste management operations for 17 industry groups[2] defined by EPA. Data from this survey have been used to represent Ind D facility locations and WMU characteristics in a variety of RCRA regulatory initiatives, including the 1995 HWIR proposal. Although the Industrial D data are more than 10 years old, they are the largest consistent set of data available on Industrial D WMU locations, dimensions, and waste volumes. Information on the survey design, response rates, and overall data quality and completeness may be found in Westat (1987), Clickner (1988), and Clickner and Craig (1988).

There were 15,844 total sites in the Indusrial D database. Of those, 2,850 reported that they managed waste in a surface impoundment, landfill, waste pile, or LAU. Only 2,839 sites, however, reported surface area, which is a required parameter for the 3MRA modeling system. Another 96 sites did not have address information because of confidential business information (CBI) claims, and 67 sites were outside of the contiguous United States (25 in Alaska and 37 in Hawaii). Some 201 sites (with a reported area and within the contiguous United States) were randomly selected for the representative national data set. When sites with no area or no address were selected, they were resampled. Table 3-3 shows the representativeness of the 201 sites selected for the representative national data set compared to the entire set of 2,850 facilities in the Industrial D Screening Survey. Section 2.0 provides general facility information, including industry group and location, for these 201 facilities.

Table 3-3. WMU Type Distribution of 201 Sample Facilities

WMU Type	201 Sample Facilities		2,850 Industrial D Facilities	
	Number	Percentage	Number	Percentage
Landfill (LF)	56	27.9	801	28.1
Land Application Unit (LAU)	28	13.9	345	12.1
Surface Impoundment (SI)	137	68.2	1,869	65.6
Waste pile (WP)	61	30.3	829	29.1

Previous EPA Composite Model for leachate migration with Transformation Products (EPACMTP) (U.S. EPA, 1997) modeling efforts have uncovered issues associated with the internal consistency of the Industrial D data. For example, for certain facilities, the remaining capacity is greater than the total capacity of the unit. In other cases, depths calculated from site-specific data are unreasonably large or small. To address such problems, questionable data have been culled and/or replaced using procedures developed for EPACMTP (described in U.S. EPA, 1997). These replacement values were generated using random realizations from the probability distribution of quantity and/or capacity conditioned on area. Table 3-4 lists the number of WMU types for the entire Industrial D data set and for the subset of 201 sites used in the 3MRA

[2]Industry groups as follows: (1) organic chemicals; (2) primary iron and steel; (3) fertilizer and agricultural chemicals; (4) electric power generation; (5) plastic and resins; (6) inorganic chemicals; (7) stone, clay, glass, and concrete; (8) pulp and paper; (9) primary nonferrous metals; (10) food and kindred products; (11) water treatment; (12) petroleum refining; (13) rubber and miscellaneous products; (14) transportation equipment; (15) selected chemical and allied products; (16) textiles; and (17) leather and leather products.

representative national data set, as well as the number of replacement values calculated for each group. Table 3-5 lists the screening constraints and equation variables used to calculate replacement values.

Table 3-4. Number of Industrial D WMUs Used for the Representative National Data Set

	Sample Facilities			Industrial D Facilities			
WMU Type	**Selected for Representative National Data Set**	**Waste Quantity Replaced**	**Capacity Replaced**	**Manage Waste in WMU**	**Report Area for WMU**	**Waste Quantity Replaced**	**Capacity Replaced**
LF	56	0	24	827	824	0 [a]	323
LAU	28	1	N/A	354	352	20	N/A
SI	137	4	21	1,930	1,926	57	262
WP	61	34	N/A	853	847	398	N/A
Total	201	39	45	2,850	2,839	468	571

[a] Waste quantity was missing for 6 landfills, but because they were not selected as part of the 201 facility subset, replacement values were not calculated.

N/A = Not applicable.

Table 3-5. Screening Constraints and Replacement Values for Industrial D Data

WMU Type	Parameter	Constraints	No. Screened/ Replaced	Regression Equation[a]		Offset Range[b]
				Slope	**y-Intercept**	
LF	Capacity	Missing Values	90	1.062004	4.050366	± 0.6
		2 ft<=Depth[c] <=33ft (OR 0.5m <=Depth[c] <=10m)	233			
WP	Waste Quantity	Missing Values	30	0.775536	3.874929	± 1
		Waste pile Height[d] >=1m	368			
LAU	Waste Quantity	Missing Values	8	0.840728	1.775842	± 1
		Application Rate[e] <=10,000 tons/acre-yr (or 2.24 Mg/m^2-yr)	12			
SI	Waste Quantity	Missing Values	57	0.775282	4.034241	± 1
	Capacity	Missing Values	24	1.075292	3.944372	± 0.8
		1 ft <=Depth[c] <=150 ft (or 0.3m<=Depth[c] <=46 m)	238			

[a] In case where constraints were violated, replacement values were calculated based on a statistical regression of known values. Each regression analysis was performed on a log scale, and the resulting best-fit line was used as the basis for estimating replacement capacities or waste quantities as a function of unit area.
[b] To provide a more probabilistic sampling, random numbers were generated within a limited range to offset replacement values from the regression best-fit line.
[c] Unit depth = unit capacity / unit area.
[d] The waste pile height is a function of waste quantity and unit area (see Section 3.5.3.2).
[e] Unit application rate = unit waste quantity / unit area.

In addition, the existing Industrial D database contains some zero values for waste quantity and area that resulted from truncation of the third decimal place in the original database. When zero area or zero waste quantity was reported, a minimum bound of 0.005 acre (equal to 20.23 m^2) or 0.005 M ton (equal to 0.005 Mg) was used (U.S. EPA, 1997).

Calculations for replacement values and other site-based model inputs are explained further in the discussion sections for each of the WMU types. Appendix 3A shows raw data from the Industrial D Screening Survey (including replacement values) for the 201 Industrial D sites addressed in this analysis. This information includes the types and numbers of WMUs at each site, the average area, the waste quantity, and the total capacity for each WMU.

3.2.2 National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities

The Industrial D Screening Survey (Westat, 1987) did not include tanks. Therefore, a tanks database was developed for this analysis that compiled flow rates and tank volumes. The primary source for these data was EPA's National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities (TSDR Survey) (U.S. EPA, 1987). This comprehensive survey requested information from 2,626 TSDR facilities concerning their 1986 hazardous waste management practices and quantities. It also included a specific questionnaire regarding tanks used at each facility. Responses were received from 2,322 facilities. Of these, 1,700 facilities provided information on 18,773 tanks.

The TSDR Survey characterizes tanks containing hazardous (Subtitle C) wastes; extensive data were not available on tanks used for nonhazardous waste management. EPA believes, however, that from the perspective of basic tank design, hazardous waste tanks should adequately represent tanks designed for treating nonhazardous wastes.

3.2.2.1 Tank Data Set. The only subset of the original TSDR Survey currently available is for facilities that received any quantity of waste from an off-site source. This subset of data contains information on 8,511 tanks located at 710 facilities (approximately 45 percent of the tanks in the survey). This reduced data set was used to characterize tanks for the representative national data set. Although it would have been preferable to use the original complete data set, including tanks at facilities that treat only wastes generated on-site, these data are, unfortunately, no longer available electronically. The subset data, however, include a broad range of tank volumes – from less than 55 gal to more than 5,000,000 gal – and it is likely that the subset data represents the range of tank volumes reported for all tanks.

Several criteria were used to guide the development of the tanks database. These criteria were applied to the TSDR Survey data to determine which tanks should be included in the representative national data set:

- *Classification* – Only aerated treatment tanks were included in the representative national data set (see Section 3.2.2.2).

- *Flow rate* – Only those tanks reporting nonzero flow rates were included in the representative national data set.

- *Open versus covered tanks* – Only open tanks were included in the representative national data set; closed or covered tanks were omitted because emissions from covered tanks are likely to be significantly lower than emissions from open tanks. Therefore, results calculated for open tanks should also be protective for exposures associated with covered tanks.

- *Tank volume* – All tanks with a volume of 55 gal or less were excluded from the representative national data set. Inclusion of a relatively large number of smaller volume tanks could skew the risk results in the direction of lower risk because these smaller tanks would tend to have smaller surface areas and smaller aeration rates (where applicable), resulting in lower emission levels. It also can be argued that these smaller volume containers should be classified as drums and not tanks due to their size.

  Additionally, the two largest tanks (approximately 30,000,000 gal), one aerated treatment and one nonaerated treatment, were reviewed because these tanks were many times larger than the next largest tanks and appeared to be nonrepresentative. The facility that owns both tanks was contacted and it was determined that the tanks in question have volumes of 3,000,000 gal and 6,000,000 gal (Allswede, 1999), values within the range represented by the other tanks in the database. The tank volumes for these tanks were corrected in the representative national data set to the values provided by the facility.

3.2.2.2 Tank Classification. Industrial tanks can be used for either storage or treatment of wastes and can be further categorized as either aerated/agitated or quiescent (i.e., not aerated or agitated). Aeration or agitation is used in wastewater treatment systems to transfer air to the liquid in order to improve mixing or increase biodegradation. Storage tanks are, by definition, quiescent because they do not include aeration processes. Treatment tanks can belong to either group.[3] The 3MRA modeling system models only aerated tanks; therefore, storage tanks and any treatment tanks identified as quiescent were not included in the representative national data set.

To determine which tanks were used for storage and which were used for aerated treatment, process codes from the TSDR Survey were evaluated. Tanks with process codes of either 2A (accumulation in tanks) or 2ST (storage in tanks) were classified as storage tanks. The TSDR Survey used a broad range of treatment codes (including codes for incinerators and belt filter presses); classification of treatment tanks was limited to those processes listed in Appendix 3B, Table 3B-1.

The process codes were evaluated further to determine the level of aeration used for treatment tanks. HI aeration was assigned to tanks that actively mix the liquid surface for the purpose of aeration or that add diffused air. LO aeration was assigned to tanks that are likely to have mixing devices used with chemical additions or other purposes. NO aeration was used for tanks that are purposefully operated to minimize mixing or agitation (e.g., a clarifier). The

[3]Examples of quiescent treatment tanks are clarifiers and filters (such as sand or mixed-media filters).

aeration level assignments for each process code are shown in Appendix 3B, Table 3B-1. The treatment tanks were subsequently divided into aerated tanks (tanks designated as HI or LO aeration) and nonaerated tanks (tanks designated as NO aeration).

The numbers of tanks included in each classification are summarized in Table 3-6. A few tanks reported multiple process codes that included both a storage code (2A or 2ST) and a treatment code. These tanks were classified as both storage and treatment tanks. The final tank data set in the representative national data set consists of 624 aerated treatment tanks.

3.2.2.3 <u>Additional Tank Data Used for Imputation</u>. To address tank-specific data gaps in the tanks database, additional data sources were identified. These data included information collected in 1985 and 1986 during EPA site visits to aerated treatment systems. These systems were selected to represent a range of aeration processes and reflect a variety of industries and waste types. To identify candidate facilities, numerous phone contacts were made with state and local environmental agencies. From these conversations, information on wastewater treatment systems at 54 facilities was collected. Site visits to these facilities were then conducted, and data on the individual tanks were provided by the facilities, including data on tank dimensions. Added to these data were five tanks from the TSDF background information document (U.S. EPA, 1991). This resulted in a supplemental database of 49 tanks (13 with high aeration, 9 with low aeration, and 27 with no aeration), presented in Appendix 3B, Table 3B-2.

In addition to these data, several tank vendors were contacted to establish a reasonable high end for tank capacity and depth based on design principles. As a result, a reasonable maximum capacity for an open, partially or completely aboveground tank was defined to be approximately 3,000,000 gal and the depth of such a tank would not be expected to exceed 10 m (about 32 ft) (Pekar, 1999).

Table 3-6. Numbers of Tanks, by Classification

Tank Classification	Number	
Storage tanks		638
Aerated treatment tanks		624
High aeration	29	
Low aeration	595	
Nonaerated treatment tanks		273
Total		1,535

To maintain the integrity of the tank database, these site visit tanks and hypothetical tanks were used only as a basis for imputing values and were not included in the representative national data set.

3.2.3 National Data

When site-specific data were not available, WMU inputs were either imputed from site-specific data using national relationships or derived directly from national data. National data sources include literature, personal communication, and best engineering judgments. Data were collected first to derive general process diagrams for WMUs and then to develop specific parameter value estimates for design variables. When no information could be found, engineering calculations or judgments were used to generate design information or values for specific parameters.

Generally, in seeking information, multiple sources were consulted in order to identify and characterize potential variability in design aspects and specific parameter values. When the design and operation of WMUs were not well-standardized, parameters likely to show wide variability were flagged, and the variability was defined by distribution parameters used for the model inputs (e.g., distribution type, minimum, maximum, mean, and standard deviation).

3.3 Methodology

The general approach for WMU data collection was to develop model facility designs based on standard industry practices and scale the designs to the unit sizes extracted from the Industrial D data. These designs are general descriptions of the key unit features that determine the parameter values of interest for the source models. Based on these designs, the parameter values have been estimated, either as fixed values or value ranges. The following steps describe this approach:

1. **Collect information to define typical WMU designs.** Initially, information was collected from the Industrial D and TSDR databases and from the literature in order to define the typical designs for each WMU. For example, aerated tank design features (relating to unit depth, size and number of impellers, and aeration method) vary depending on unit size, flow rate of waste through the unit, and materials being treated. The collected information was then used to determine the number and general characteristics of the model facilities for each type of WMU.

2. **Collect detailed data for each WMU model design.** Once the general WMU model facility designs were reviewed, information was collected about the specific parameter values for each design. In general, multiple sources were consulted for each parameter in order to identify and characterize typical ranges for parameter estimates. When no information was available in the literature for a parameter, engineering calculations were made, where possible, based on other aspects of facility design. As a final option, engineering judgment was used as a basis for developing data.

3.3.1 Site-Specific Data

Site-specific data describing waste management practices for surface impoundments, landfills, waste piles, and LAUs were obtained from the Industrial D Screening Survey (Westat, 1987). Available data include the following:

- Surface impoundments – Total area, total 1985 waste quantity, total capacity, and number of units;

- Landfills – Total area, total 1985 waste quantity, total capacity, remaining capacity, and number of units;

- Waste piles – Total area, total 1985 waste quantity, and number of units; and

- LAUs – Total area, total 1985 waste quantity, and number of units.

WMU total area and total 1985 waste quantity were available and used for all four WMU types. Total capacity was available only for landfills and surface impoundments. For all parameters, average values were calculated by dividing the total values by the number of units at a site.

In addition, site-specific data were obtained and used for landfill cover soil properties, LAU soil properties, and soil type underlying the waste pile. These properties were obtained from nationwide soil coverages as described in Section 7.0. Surface soil (top 20 cm) properties were used for LAUs and waste piles, with the landfill cover soil assumed to have the average or predominant soil properties for the vadose zone underlying the WMU.

3.3.2 Site-Based Data

For model inputs based on the site-specific data described in Section 3.3.1 (e.g., Ind D WMU size or capacity), site-based data were derived using relationships based on the published literature and best engineering judgment. The data were processed using a combination of database and spreadsheet tools. As appropriate, Industrial D data were used in a consistent fashion to other Office of Solid Waste (OSW) modeling efforts (e.g., Air Characteristic/Industrial D modeling effort). Aspects of this approach include the following:

- When WMU dimensions (length and width) were needed, a square unit was assumed.

- For landfills and surface impoundments, depth was calculated based on area, total capacity, and typical waste bulk density.

- Landfill loading rates were determined based on total capacity and fixed (30-yr) operating life.

- Annual waste loading rates were estimated for surface impoundments, waste piles, and LAUs based on waste generation rates for 1985 (i.e., total 1985 waste quantity).

3.3.3 National Tank Data (Correlated)

Because the TSDR sites could not be directly related to the sites in the Industrial D Screening Survey, for modeling purposes, the assumption was made that if one of the Industrial D sites contained a surface impoundment, then it also contained an aerated tank. The 3MRA modeling system randomly picks an aerated tank from the TSDR data set, referred to as the national tank data set, using a tank index parameter (ATindex). It then correlates the data from the selected tank to the Industrial D facility being modeled.

To ensure that the selected tank is no larger than a surface impoundment at the site, a maximum source area (MaxSrcArea) is provided. MaxSrcArea is set equal to the source area for the surface impoundment being modeled. Surface impoundment areas range from 13.5 to 60,705,000 m^2. Aerated tank areas range from 0.06 to 4,694 m^2. The modeling system loops through the selection process until an acceptable tank is chosen (i.e., tank area <= MaxSrcArea). Because the smallest tank is less than the smallest surface impoundment, a tank smaller than the MaxSrcArea will always be available. Once a tank is selected, all the parameters for that tank are assigned to the Industrial D site.

3.3.4 Other National Data

When site-based data were unavailable, inputs were derived on a national basis. Each of these inputs was defined by its type of distribution (e.g., constant, uniform, normal, lognormal). In addition, distribution parameters including mean, minimum, maximum, and standard deviation were provided where applicable.

3.4 Landfill Module Inputs

This section describes the approach used to develop inputs for the Landfill Module. The Landfill Module design is described in Section 3.4.1. Sections 3.4.2 through 3.4.4 describe the development of input parameters for site-specific, site-based, and national data, respectively. For site-based variables, relationships between site-specific and site-based input parameters are identified and considered to ensure that related inputs are not randomly selected in a manner that would create physically impossible or unrealistic combinations.

Table 3-7 summarizes the data collected for Landfill Module inputs. It is organized by site-specific and site-based data, which are extracted directly or calculated from Industrial D Screening Survey data, and national data, which are based on relationships taken from books, reports, and professional judgment.

3.4.1 Landfill Module Design

Landfill data collection assumes that only one type of landfill is used for disposal of waste, (i.e., that there are no significant differences in the design of landfills depending on size or purpose). As with all other WMU parameters except aerated tanks, average landfill dimensions and capacity (i.e., total/number of units) are used from the Industrial D database. Other significant assumptions are that the landfill is excavated below ground surface, the unit

Table 3-7. WMU Data Collected for the Landfill Module

Variable	Units	Code	Value	Original Source
Site-Specific Data				
WMU type	unitless	SrcType	specified “LF”	Industrial D Screening Survey (Westat, 1987)
area of source	m^2	SrcArea	SrcArea = [total area]/[no. landfills]	Industrial D Screening Survey (Westat, 1987); average
fraction organic carbon (cover soil)	mass fraction	focC	depth-weighted average, entire soil column under WMU based on predominant soil texture for vadose zone soils underlying WMU (see Section 7.0)	USSOILS (Schwarz and Alexander, 1995)
saturated hydraulic conductivity (landfill cover soil)	cm/h	KsatC		CONUS (Miller and White, 1998); Carsel and Parrish (1988)
saturated water content (cover soil, total porosity)	volume fraction	WCS_C		CONUS (Miller and White, 1998); Carsel and Parrish (1988)
soil moisture coefficient b (landfill cover soil)	unitless	SMbC		CONUS (Miller and White, 1998); Clapp and Hornberger (1978)
Site-Based Data				
depth of source	m	SrcDepth	capacity/[area x bulk density] (Equation LF-1)	capacity (Mg) and area from Industrial D Screening Survey (Westat, 1987); assumed waste bulk density to get capacity in m^3
load	Mg/yr	---	capacity/30 (Equation LF-2)	calculated from Industrial D Screening Survey; assumes a 30-yr operating life
waste zone thickness	m	zW	zW = SrcDepth	calculated from Industrial D Screening Survey
distance vehicle travels on active landfill cell surface	m	mt	mt = width of landfill = sqrt(SrcArea) (Equation LF-3)	calculated from Industrial D Screening Survey; assumes a square landfill
vehicles per day (mean annual)	1/d	nv	nv = capacity/[operating life x payload x 365.25] (Equation LF-4)	best professional judgment, based on Industrial D capacity data
spreading and compacting operations per day	1/d	Nop	Nop = nv (Equation LF-5) maximum value = 2	best professional judgment
frequency of surface disturbances per month (active landfill cell)	1/mo	fd	fd = Nop x 30 (Equation LF-6)	best professional judgment

(continued)

Table 3-7. (continued)

Variable	Units	Code	Value	Original Source
vehicle weight (mean)	Mg, m^3	vw	vw = payload/2 + w_{empty} (Equation LF-7)	Overcash and Pal (1979)
wheels per vehicle (mean)	unitless	nw	calculated site-specific depending on payload; 6 wheels for a small truck and 10 for a large truck	best professional judgment based on information from Overcash and Pal (1979) and MRI (1990)
number of waste layers in a cell	unitless	Nly	SrcDepth $\leq$ 1: (Table LF-8) Nly = 1 1 < SrcDepth $\leq$ 2: Nly = 2 SrcDepth > 2: Nly = Integer(SrcDepth)	best professional judgment
National Data				
optional soil cover thickness	m	zC	triangular distribution: minimum = 0.3 maximum = 0.9 mean = 0.6	best professional judgment, assuming a simple soil cover designed to support vegetative cover, based on Tchobanoglous (1993), Bagchi (1990), and McBean (1995)
thickness of liner (or subsoil zone)	m	zS	constant = 0	model scenario assumes an unlined landfill
dust suppression control efficiency	unitless	effdust	normal distribution: minimum = 0 maximum = 1 mean = 0.5 standard deviation = 0.3	best professional judgment based on U.S. EPA (1989)
dust suppression control efficiency	unitless	effdust	normal distribution: minimum = 0 maximum = 1 mean = 0.5 standard deviation = 0.3	best professional judgment based on U.S. EPA (1989)
fraction vegetative cover (inactive LF cell)	unitless	veg	normal distribution: minimum = 0.8 maximum = 1 mean = 0.9 standard deviation = 0.1	best professional judgment, assuming landfill cover is vegetated once unit is closed

(continued)

Table 3-7. (continued)

Variable	Units	Code	Value	Original Source
roughness height (inactive landfill cell)	cm	zruf	normal distribution: minimum = 2 maximum = 4 mean = 3 standard deviation = 0.6	best professional judgment based on U.S. EPA (1989)
roughness ratio (landfill waste zone surface)	unitless	Lc	lognormal distribution: minimum = 1E-04 maximum = 1E-03 mean = 3E-04 standard deviation = 0.304	best professional judgment based on U.S. EPA (1989)
vehicle speed	km/h	vs	normal distribution: minimum = 20 maximum = 40 mean = 30 standard deviation = 6.1	Overcash and Pal (1979)

receives waste for 30 years, the landfill is capped with soil cover to establish a vegetative cover after a cell is filled, and there is no liner.

3.4.2 Landfill Site-Specific Data

Site-specific data for landfills were obtained from the Industrial D Screening Survey (Westat, 1987). These include total area, number of landfills at each site, total capacity, remaining capacity, and total 1985 annual waste quantity. Average values were calculated for use in the representative national data set by dividing the Industrial D data for each of the parameters by the number of landfills at each site. Appendix 3A shows raw data from the Industrial D Screening Survey for the 201 Industrial D sites included in the representative national data set.

3.4.2.1 Screening and Replacement of Industrial D Data. In accordance with previous EPA modeling efforts using the Industrial D Screening Survey, landfill capacities were screened from the Industrial D data when depth or capacity constraints were violated. Questionable data were screened using the following procedures (U.S. EPA, 1997):

> The landfill data were screened by placing constraints on the unit depth and unit volume to eliminate unrealistic observations. The unit depth, calculated by dividing the unit capacity by the unit area, was constrained to be either greater than or equal to 2 feet, or less than or equal to 33 feet. The unit depth bounds were adopted from the previous TC rule effort.

Of the 824 landfills (reporting surface area) in the Industrial D Screening Survey, 170 had a depth less than 2 ft (0.5m) and 63 had a depth greater than 33 ft (10 m). In addition, 90 facilities were missing data on total capacity. Thus, landfill capacity was missing or screened for 323 landfills.

Landfill capacities to replace the 323 missing or removed values were estimated based on the correlation between surface area and capacity of the remaining landfills in the Industrial D data. The procedure used to replace values was similar to the EPACMTP methodology (U.S. EPA, 1997):

> In cases where the unit depth or remaining capacity constraints were violated, the observed unit volume was replaced by generating a random realization from the volume probability distribution conditioned on area assuming that the unit area value was more likely to be correctly reported. The joint distribution was derived from the non-missing unit area/volume pairs that met the unit depth and remaining capacity constraints and was assumed to be lognormal. Missing values were generated from the joint area/volume probability if both the area and volume were missing, and from the corresponding conditional distribution if only one of the two values was missing. Final depth values were calculated by dividing the unit volume by the area.

First, a statistical regression of log (average capacity) versus log (average surface area) was done on the facilities with known capacities. The regression yielded an equation for a best-fit line through the known values. This equation gave the capacity as a function of area, so the missing or screened capacities could be estimated based on the known areas. To provide a more probabilistic sampling of average capacities, and because the known capacities seemed to be in a limited range (± 0.6) above and below the best-fit line, a positive or negative random number was generated within that range and added to the calculated log (average capacity) to replace each missing capacity with a random value that was reasonable with respect to landfill area. This value was then used to calculate landfill depth as described above. Figure 3-1 shows the regression plots, including the replaced (random capacity) values, for landfills.

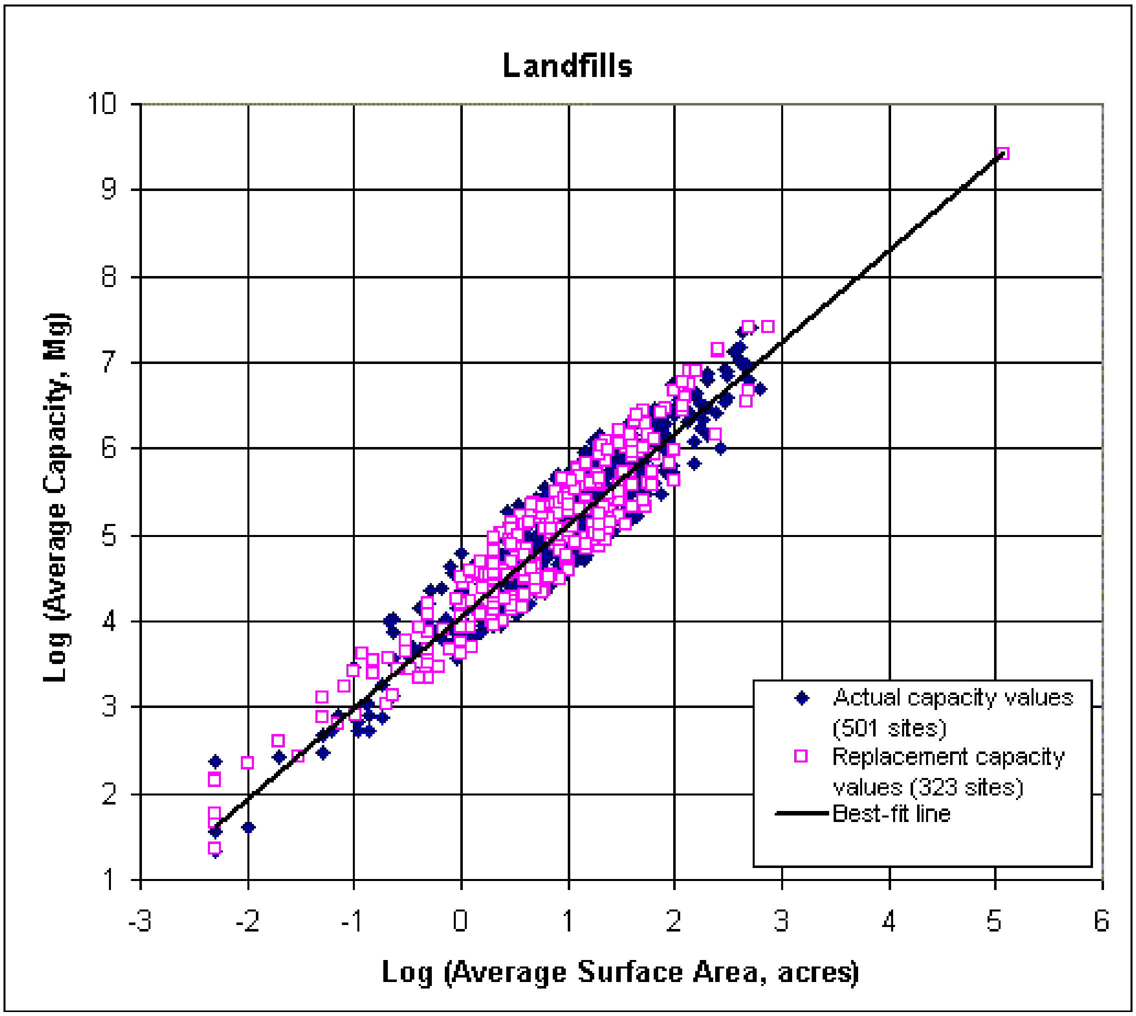

Figure 3-1. Correlation of total capacity to area for landfills.

3.4.2.2 <u>Cover Soil Properties</u>. For purposes of this analysis, it was assumed that the soil used to cover the landfill was obtained from soil at or very nearby the facility and, in many cases, could be soil excavated to construct the landfill itself. Thus, soil properties for the vadose zone directly underlying the landfill were used for cover soil properties. The following cover soil parameters have been collected for use by the Landfill Module: fraction organic carbon (focC), saturated hydraulic conductivity (KsatC), saturated water content (WCS_C), and soil moisture coefficient b (SmbC). See Section 7.0 for a discussion on vadose zone soil property data collection.

3.4.3 Landfill Site-Based Data

Site-based data are derived from Industrial D data (notably average area and average capacity), using relationships based on the published literature and best engineering judgment.

3.4.3.1 <u>Depth (SrcDepth)</u>. Landfill depth (SrcDepth) was calculated consistent with previous EPACMTP modeling efforts using the Industrial D data (as described in U.S. EPA, 1997). The wet bulk density assumed for landfills was 1.8 g/cm^3.

$$\text{depth (m)} = \frac{\text{landfill capacity (Mg)} \times 1\times10^6\,\text{g/Mg}}{\text{area (m}^2) \times \text{bulk density (g/cm}^3) \times (100\,\text{cm/m})^3} \tag{LF-1}$$

3.4.3.2 <u>Waste Loading Rate (load)</u>. The waste loading rate (load) is the annual quantity of waste disposed at a landfill. Because data on the typical design life for landfills were not available, a 30-yr operating life was assumed as a reasonable value based on professional judgment.

$$\text{load (Mg/yr)} = \frac{\text{landfill capacity (Mg)}}{30\,\text{yr}} \tag{LF-2}$$

3.4.3.3 <u>Distance Vehicle Travels on Active Landfill Cell Surface (mt)</u>. Assuming a square landfill unit configuration and assuming that a truck drives into the center of the landfill to deliver a load of waste, the length of unpaved road on the uncovered landfill is assumed to be equal to half the width of the landfill. The vehicle travels in and out on the road to deliver a load of waste, so the distance a vehicle travels on the active landfill surface (mt) is equal to the landfill width.

$$\text{mt (m)} = \text{width (m)} = \sqrt{\text{area (m}^2)} \tag{LF-3}$$

3.4.3.4 <u>Average Number of Vehicles per Day (nv)</u>. The average number of vehicles per day (nv) is calculated assuming the landfill has a 30-yr operating life and that each truck carries a full payload.

$$\text{nv (1/d)} = \frac{\text{landfill capacity (Mg)}}{30\,\text{yr} \times \text{payload (Mg)} \times 365.25\,\text{(d/yr)}} \tag{LF-4}$$

where

payload = 35 Mg if landfill capacity >= 30,000 Mg/yr
payload = 15 Mg if landfill capacity < 30,000 Mg/yr.

3.4.3.5 <u>Number of Spreading and Compacting Operations per Day (Nop)</u>. The number of spreading and compacting operations (Nop) is the number of times that the whole landfill cell area is compacted with heavy equipment. The number of loads dropped off are equal to the average number of vehicles (nv) at the landfill. The number of spreading and compacting operations per day is specified by the following equation (with a maximum value of 2):

$$Nop(1/d) = nv(1/d) \tag{LF-5}$$

3.4.3.6 <u>Frequency of Disturbances per Month (fd)</u>. A disturbance is defined as an action that results in the exposure of fresh surface material. This can occur whenever material is added to the landfill cell or the waste is compacted or moved. The frequency of disturbances (fd) equals the number of spreading and compacting events per day (Nop) multiplied by the number of days per month.

$$fd(1/mo) = Nop(1/d) \times 30(d/mo) \tag{LF-6}$$

3.4.3.7 <u>Vehicle Weight (vw), Payload, and Number of Wheels (nw)</u>. Two typical truck sizes were developed for this analysis: small and large. Data on typical truck payloads and number of wheels per truck were obtained from Overcash and Pal (1979) and Midwest Research Institute (MRI) (1990). Data for determining the ratio of total to empty vehicle weight were obtained from Caterpillar (1994).

A small truck is assumed to have 6 wheels and a full weight of 30 Mg (15 Mg vehicle weight empty plus 15 Mg payload). The vehicle weight estimate is based on a payload size of 10 m^3 (roughly midrange for dump trucks in Overcash and Pal, 1979), a waste bulk density of about 1.5 Mg/m^3, and a ratio of weight loaded to weight unloaded of about 2.

A large truck is assumed to have 10 wheels and a full weight of 65 Mg (30 Mg vehicle weight empty plus 35 Mg payload). This vehicle weight estimate is based on a payload size of about 23 m^3 (the upper end of the dump truck sizes in Overcash and Pal, 1979), a waste density of about 1.5 Mg/m^3, and a ratio of weight loaded to weight unloaded of about 2.2.

For units managing less than 30,000 Mg/yr, a small truck is assumed. For units managing 30,000 Mg/yr or more, a large truck is assumed. Depending on the quantity of waste managed at the landfill, the appropriate truck payload is used in Equation LF-7.

The vehicle weight is used in particulate emission calculations. A full truck is assumed to drive onto the unit, dump its load, and then exit empty. The vehicle weight (vw) is the average of its weight full and empty. The weight of the vehicle is expressed as follows:

$$vw(Mg) = \frac{w_{full}(Mg) + w_{empty}(Mg)}{2} = \frac{payload(Mg)}{2} + w_{empty}(Mg) \tag{LF-7}$$

where

vw	=	vehicle weight for a small or large truck (Mg)
payload	=	carrying capacity of the truck (Mg)
w_{full}	=	vehicle weight when full (Mg) = w_{empty} (Mg) + payload (Mg)
w_{empty}	=	vehicle weight when empty (Mg).

The vehicle weight depends on the size of the vehicle (large or small) and the vehicle payload. Small trucks are assumed to have a weight empty of 15 Mg, a payload of 15 Mg, and 6 wheels. Large trucks are assumed to have a weight empty of 30 Mg, a payload of 35 Mg, and 10 wheels.

In the absence of other data, the average fraction of a full load that a truck carries is assumed to be 1 (i.e., the truck carries a full load each time because operating the truck at less than a full load would be inefficient). A full load is considered to be a volume of waste equal to the volume of the truck dumper (rather than waste loaded in such a way as to mound above the sides of the truck dumper).

3.4.3.8 Number of Waste Layers in a Cell (Nly). A waste layer in the landfill is a waste zone of uniform thickness within each landfill cell wherein initial constituent concentrations are assumed uniform by the Landfill Module. In other words, each annual landfill cell contains one or more uniform layers formed over time by the dumping of truck loads of waste in the landfill cell. For this analysis, the number of waste layers (Nly) is determined as follows:

Landfill Depth, m (SrcDepth)	Number of waste layers in a cell (Nly)
≤ 1	1
>1 and ≤ 2	2
>2	Integer (SrcDepth)

(LF-8)

3.4.4 Landfill National Data

National data were collected for input variables when site-specific data were not available and the variable was not correlated with other site-specific data. In most cases, a distribution was assumed to account for nationwide variability in parameter values.

3.4.4.1 Optional Soil Cover Thickness (zC). The Industrial D landfill is assumed to have a simple soil cover designed to establish a vegetative cover on the closed landfill, not to limit infiltration into the landfill. This conservative assumption is consistent with the assumption of no engineered liner under the WMU. For the Landfill Module, the minimum depth of this soil cover is assumed to be 0.3 m and the maximum depth is 0.9 m. A triangular distribution is assumed, with a mean of 0.6 m.

3.4.4.2 Thickness of Liner (or Subsoil Zone) (zS). This parameter allows a liner to be used in the Landfill Module but was set at zero for the representative national data set, reflecting the assumption that Industrial D landfills are unlined.

3.4.4.3 Dust Suppression Control Efficiency (effdust). Dust suppression activities might include the watering of the landfill to reduce dust or the application of chemical dust suppressants (U.S. EPA, 1989). A value of zero corresponds to no dust suppression activity. Although information was available about types of dust suppression control activities, there is no definitive information quantifying the frequency of use or the effectiveness of these activities. Consequently, it is assumed that dust suppression control efficiency (effdust) has a normally distributed value between 0 and 1, with a mean of 0.5 and a standard deviation of 0.3.

3.4.4.4 Fraction Vegetative Cover (veg). After closure of the unit, it is assumed that the landfill is covered with vegetation. To allow for some variability in the extent of this cover, the fraction vegetative cover (veg) is specified as a normal distribution from 0.8 to 1, with a mean of 0.9 and a standard deviation of 0.1.

3.4.4.5 Roughness Height (zruf). This factor is the height aboveground at which the wind speed becomes zero due to obstructions (rocks, plants) on the ground surface (U.S. EPA, 1989). Roughness height (zruf) ranges from 0.1 cm to 1,000 cm for snow to urban settings. EPA provides some values for the roughness height for various sites in Arizona and for industrial aggregates, as well as a chart of values for different settings. After closure, the landfill is assumed to be similar to a grassland with a roughness height ranging from 2 cm to 4 cm, normally distributed, with a mean of 3 cm and a standard deviation of 0.6 cm.

3.4.4.6 Roughness Ratio (Lc). This factor is the ratio of the silhouette area of the roughness elements (>1 cm) in the soil to the total bare loose soil. Roughness ratio (Lc) can range from 0 to 0.01 (U.S. EPA, 1989). For the representative national data set, it is assumed to be lognormally distributed, with a minimum of 1×10^{-4}, a maximum of 1×10^{-3}, a mean of 3×10^{-4}, and a standard deviation of 0.304. Higher Lc values ($>2\times10^{-4}$) increase the threshold wind speed for the onset of wind erosion (causing lower particulate emissions). Therefore, assuming the mean and maximum Lc equal 3×10^{-4} and 1×10^{-3} is conservative with respect to particulate emissions (but not other emission processes).

3.4.4.7 Vehicle Speed (vs). Vehicle speed (vs) is the average speed that trucks travel on the landfill. For surface spreading, 20 to 40 km/h is a representative range (Overcash and Pal, 1979). Vehicle speed is specified as a normal distribution, with a mean of 30 km/h and a standard deviation of 6.1 km/h.

3.5 Waste Pile Module Inputs

This section describes the approach used to develop inputs for the Waste Pile Module. The Waste Pile Module design is described in Section 3.5.1. Sections 3.5.2 through 3.5.4 describe the development of input parameters for site-specific, site-based, and national data, including data sources, ranges, and assumptions. For site-based variables, relationships between site-specific and site-based input parameters are identified and considered to ensure that related inputs are not randomly selected in a manner that would create physically impossible or unrealistic combinations.

Table 3-8 summarizes the data collected for Waste Pile Module inputs. It is organized by site-specific and site-based data, which are extracted directly or calculated from Industrial D Screening Survey data, and national data, which are based on relationships taken from books, reports, and professional judgment.

3.5.1 Waste Pile Module Design

Waste piles are essentially temporary units used for storing or accumulating waste prior to final treatment or disposal. Waste piles are composed of solid waste materials that are dumped into a pile and may be subsequently moved or spread. Because a waste pile is a temporary unit, it is modeled so that the waste is deposited, remains in the waste pile for a period of time, and is then removed and replaced with a fresh waste pile with chemical concentrations equal to that of the original incoming waste. In this model, a waste is considered to be delivered by dump truck to the unit location and deposited to create a pile of uniform height throughout the area of the unit. The pile is assumed to be refreshed at least once every 5 yr, although a greater refresh frequency may occur for Industrial D facilities with large waste generation rates and relatively small waste pile areas.

The waste pile is assumed to be placed directly on native soil, with no compaction or liner underneath. There is no cover (engineered or otherwise) and no control practices are employed to limit water or wind erosion or volatile emissions from the pile.

3.5.2 Waste Pile Site-Specific Data

Site-specific data for waste piles were limited to data from the Industrial D Screening Survey (Westat, 1987). Industrial D data included total area, number of waste piles at each site, and total 1985 annual waste quantity (or waste loading). Average values were calculated for use in the representative national data set by dividing the total area and total annual waste quantity by the number of units at each site. Appendix 3A shows raw data from the Industrial D Screening Survey (including replacement values) for the 201 Industrial D sites included in the representative national data set.

In some cases, the annual waste quantity was screened due to unrealistic values or missing data. Replacement values were calculated under two conditions: (1) if surface area data were reported for a given waste pile but the waste quantity was not provided or (2) if the minimum waste pile height constraint of 1 m was violated when the refresh rate was once every 5 yr.

The first condition for replacing waste quantities is consistent with previous EPACMTP efforts (U.S. EPA, 1997):

> Missing volume values were replaced by random realizations from the probability distribution of volume conditioned on area. The conditional distribution was

Table 3-8. WMU Data Collected for the Waste Pile Module

Variable	Units	Code	Value	Original Source
Site-Specific Variables				
WMU type	unitless	SrcType	specified "WP"	Industrial D Screening Survey (Westat, 1987)
area of source	m^2	SrcArea	SrcArea = [total area]/[no. waste piles]	Industrial D Screening Survey (Westat, 1987); average values
waste loading rate (dry)	Mg/yr	load	load = [1985 total waste quantity]/[no. waste piles]	Industrial D Screening Survey (Westat, 1987); average values; missing or inconsistent values replaced using the approach outlined in the EPACMTP model background document (U.S. EPA, 1997)
Site-Based Variables				
distance vehicle travels on waste pile surface (unpaved road)	m	mt	mt = width of WP = sqrt (SrcArea) (Equation WP-1)	calculated from Industrial D Screening Survey; assumes a square unit and that on average a vehicle drives into the middle of the unit and back out
height of waste pile above grade	m	zZ1WMU	calculated using Table WP-2	best professional judgment; heights determined using waste quantity and source area from Industrial D Screening Survey
vehicle weight (mean)	Mg, m^3	vw	based on facility size (Equation WP-4) *small truck*: weight (empty): 15 Mg payload: 15 Mg *large truck*: weight (empty): 30 Mg payload: 35 Mg	best professional judgment, based on information from Overcash and Pal (1979), MRI (1990), and Caterpillar (1994)
wheels per vehicle (mean)	unitless	nw	based on facility size *small truck*: 6 *large truck*: 10	best professional judgment, based on information from Overcash and Pal (1979) and MRI (1990)

(continued)

Table 3-8. (continued)

Variable	Units	Code	Value	Original Source
Site-Based Variables				
vehicles per day (mean annual)	1/d	nv	nv = load/[payload × 365.25] (Equation WP-5)	engineering calculation; load (i.e., waste application rate) calculated from Industrial D Screening Survey data; relationship of truck size to waste application rate based on best professional judgment; truck designs based on Overcash and Pal (1979) and Caterpillar (1994)
spreading/compacting operations per day	1/d	Nop	Nop = nv (Equation WP-6) maximum value = 2	best professional judgment
SCS curve number	unitless	CNwmu	assigned using a triangular distribution based on hydrologic soil group (see Table 3-8)	best professional judgment on range of waste pile cover effect; site-specific hydrologic soil groups obtained from STATSGO (USDA, 1994)
National Variables				
dust suppression control efficiency	unitless	effdust	normal distribution: minimum = 0 maximum = 1 mean = 0.5 standard deviation = 0.3	best professional judgment, based on information from U.S. EPA (1989)
operating life	yr	CutOffYr	constant = 30	best professional judgment
vehicle speed (mean)	km/hr	vs	normal distribution: minimum = 20 maximum = 40 mean = 30 standard deviation = 6.1	best professional judgment, based on information in Overcash and Pal (1979)
USLE cover factor	unitless	Cwmu	constant = 1	Wanielista and Yousef (1993); assumed no cover
USLE erosion control factor	unitless	Pwmu	constant = 1	Wanielista and Yousef (1993); assumed no erosion control

assumed to be lognormal and was derived from the non-missing unit area/volume pairs.

The second condition (waste pile height constraint) was established because a waste pile is supposed to be a pile with some significant height and it is supposed to be a temporary unit. The minimum height and refresh frequency were selected based on judgment (see Sections 3.5.3.3 and 3.5.3.4). For a waste bulk density of 1.5 Mg/m^3, the 1-m height and once-per-5-yr refresh rate constraints correspond to an application rate of 0.3 Mg/m^2/yr. Of the 847 facilities reporting waste piles (and surface area), 30 facilities did not provide data on waste quantity and 368 values were screened by the minimum height and refresh rate constraint.

To calculate replacement waste quantities, first a statistical regression of log (waste quantity) versus log (average surface area) was performed on facilities with known quantities. The regression yielded an equation for a best-fit line through the known values. This equation gave the waste quantity as a function of area, so the missing or screened waste quantities could be estimated based on the known areas. To provide a more probabilistic sampling of average waste quantities, and because the known quantities seemed to be in a limited range (± 1) above and below the best-fit line (with some outliers), a positive or negative random number was generated within that range. This random number was then added to the calculated log (average waste quantity) to replace each missing waste quantity with a random value that was reasonable with respect to waste pile area. Figure 3-2 shows the regression plot, including the replaced (random waste quantity) values for waste piles.

3.5.3 Waste Pile Site-Based Data

Site-based data are derived from Industrial D data (e.g., average area, width, and height of waste piles), using relationships based on the published literature and best engineering judgment. In addition, the waste pile curve number (CNwmu) was derived from site-specific soil data and general assumptions about the water-holding properties of the waste.

3.5.3.1 Distance Vehicle Travels on Waste Pile Surface (mt). Although the shape of a waste pile is likely irregular, for purposes of this analysis, all WMUs are assumed to be square. It also is assumed that a truck drives into the center of the waste pile unit to deliver a load of waste (i.e., half the width of the waste pile). The vehicle travels in and out on the unpaved road to deliver a load of waste, so the distance traveled (mt) equals the width of the waste pile as follows:

$$mt(m) = width(m) = \sqrt{area(m^2)} \qquad \text{(WP-1)}$$

3.5.3.2 Height of the Waste Pile Above Grade (zZ1WMU, SHight). Waste pile height varies and will affect the rate at which waste in the unit is refreshed in the Waste Pile Module. Site-specific waste pile height information was not available. In general, however, the height of a waste pile is a function of the area of the unit and the annual waste quantity managed in the unit. Discrete pile height values ranging from 1 to 10 m were assumed in order to simplify the meteorological component of the data required for the Waste Pile Module. In particular, a calculation was required to adjust the wind speed from the height of the measuring device to the

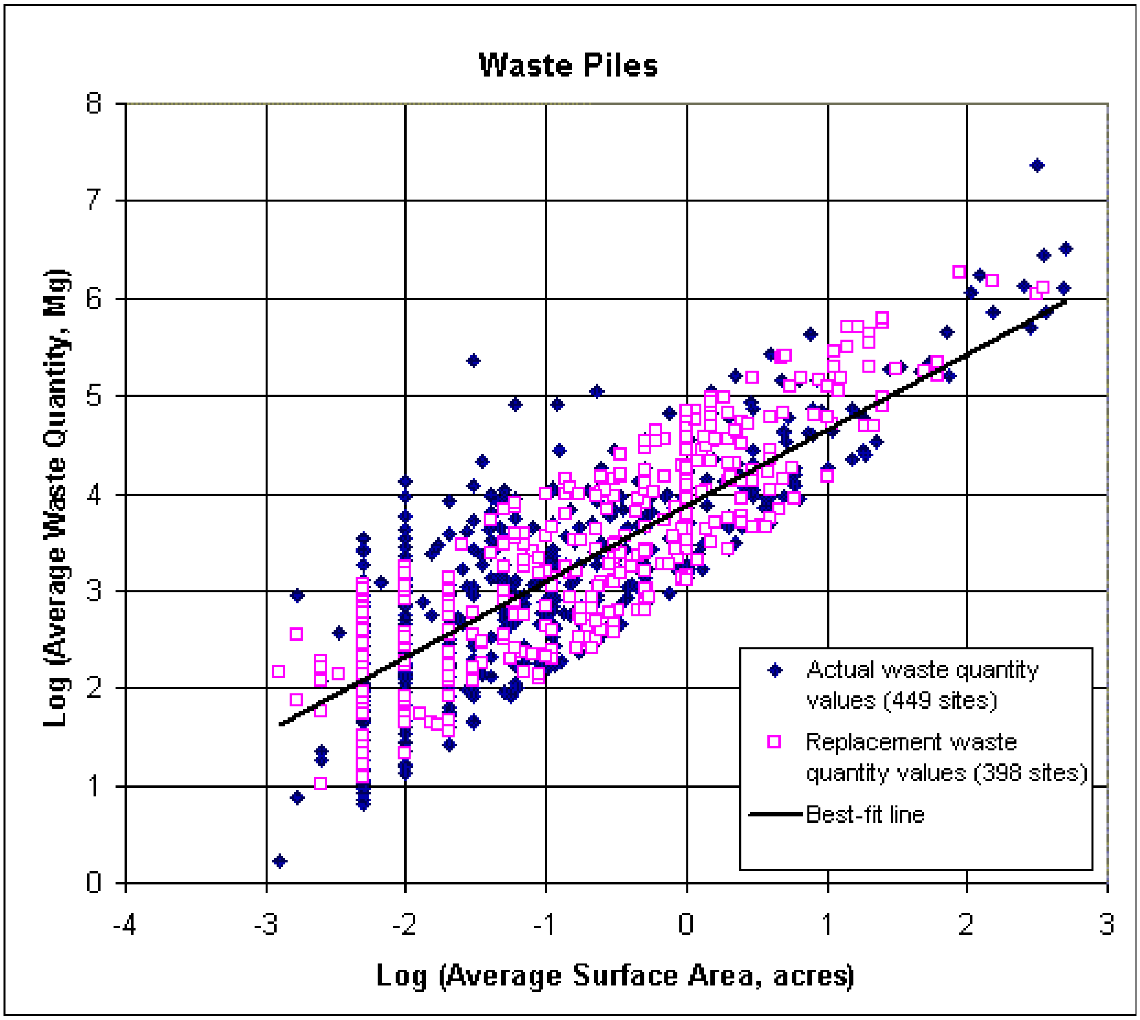

Figure 3-2. Correlation of waste quantity to area for waste piles.

height of the waste pile. The choice of heights was based on an interval over which the wind velocity differences would not be too large. The extremes were selected using best professional judgment. The relationships between pile height and the annual waste quantity per unit area were assumed based on best judgment. The following table lists the pile heights (zZ1WMU, SHight) as determined by the annual waste quantity to surface area ratio.

Annual Waste Quantity/Surface Area ($Mg/m^2/yr$)	Pile Height (m)
≥0.3, <10	1
≥10, <20	2
≥20, <40	4
≥40, <60	6
≥60, <80	8
≥80	10

3.5.3.3 Refresh Frequency. The refresh frequency is used as a constraint for screening data (discussed in Section 3.5.2). The pile height, area, and annual waste loading determine the frequency of waste pile replacement, or the refresh frequency. This can be expressed as follows:

$$\text{refresh frequency (1/yr)} = \frac{\text{annual waste loading (Mg/yr)}}{\text{area}(\text{m}^2) \times \text{height}(\text{m}) \times \text{bulk density}(\text{Mg/m}^3)} \qquad \text{(WP-2)}$$

Because waste piles are considered to be temporary units, the refresh frequency should not be too long. The minimum refresh frequency for a waste pile was assumed as once every 5 years, assuming a waste bulk density of 1.5 Mg/m^3. The Industrial D database contains combinations of waste loading and area data that, given the method used here for determining waste pile height, would lead to refresh frequencies of less than once every 5 yr. In these cases, the annual waste loading data were culled from the data set and replaced with a value randomly selected based on the distribution of valid waste pile area/annual waste loading combinations in the Industrial D database (see Section 3.5.2).

3.5.3.4 Vehicle Weight (vw), Payload, and Number of Wheels (nw). Two typical truck sizes were developed: small and large. Data on typical truck payloads (and number of wheels per truck) were obtained from Overcash and Pal (1979) and MRI (1990). Data for determining the ratio of the total vehicle weight to the weight empty were obtained from Caterpillar (1994).

A small truck is assumed to have 6 wheels and a full weight of 30 Mg (15 Mg vehicle weight empty plus 15 Mg payload). The vehicle weight estimate is based on a payload size of 10 m^3 (roughly midrange for dump trucks in Overcash and Pal, 1979), a waste bulk density of about 1.5 Mg/m^3, and a ratio of weight loaded to weight unloaded of about 2.

A large truck is assumed to have 10 wheels and a full weight of 65 Mg (30 Mg vehicle weight empty plus 35 Mg payload). This vehicle weight estimate is based on a payload size of about 23 m^3 (the upper end of the dump truck sizes in Overcash and Pal, 1979), a waste density of about 1.5 Mg/m^3, and a ratio of weight loaded to weight unloaded of about 2.2.

The average number of vehicles used per waste application was not available from the literature. Instead, the average number of vehicles was calculated by assigning a truck size to the facility based on the amount of waste managed in the unit annually. For units managing less than 30,000 Mg/yr, a small truck was assumed. For units managing 30,000 Mg/yr or more, a large truck was assumed. For facilities managing just under 30,000 Mg/yr of waste, from Equation WP-2 we would calculate 2,000 trucks per year, or an average of about 5.5 trucks per day for year-round operation.

The vehicle weight (vw) is used in the particulate emission calculations. A full truck is assumed to drive onto the unit, dump its load, pick up waste from the old pile, and then exit full. The vehicle weight is its weight full, expressed as follows:

$$\text{vw(Mg)} = \text{w}_{\text{empty}}\text{(Mg)} + \text{payload(Mg)} \qquad \text{(WP-3)}$$

where

vw	=	vehicle weight for a small or large truck (Mg)
payload	=	carrying capacity of the truck (Mg)
w_{empty}	=	vehicle weight when empty (Mg).

The vehicle weight depends on the size of the vehicle (large or small) and the vehicle payload. Small trucks are assumed to have a weight empty of 15 Mg, a payload of 15 Mg, and 6 wheels. Large trucks are assumed to have a weight empty of 30 Mg, a payload of 35 Mg, and 10 wheels.

3.5.3.5 <u>Vehicles per Day (nv)</u>. The average number of vehicles per day (nv) is determined by the annual waste application rate and the size of the truck. The relationship can be expressed as follows:

$$nv(1/d) = \frac{load(Mg/yr)}{payload(Mg) \times 365.25(d/yr)} \qquad \text{(WP-4)}$$

where

nv	=	number of vehicles per day (1/d)
load	=	waste application rate (Mg/yr)
payload	=	carrying capacity of the truck (Mg).

3.5.3.6 <u>Spreading/Compacting Operations per Day (Nop)</u>. The number of spreading or compacting operations (Nop) is the number of times that the waste pile is spread and compacted with heavy equipment. The number of spreading and compacting operations per day is specified by the following equation (with a maximum value of 2):

$$Nop(1/d) = nv(1/d) \qquad \text{(WP-5)}$$

3.5.3.7 <u>SCS Curve Number (CNwmu)</u>. Soil Conservation Survey (SCS) curve number (CNwmu) values appropriate for waste piles could not be found in the open literature. To estimate this parameter, a scenario was developed in which the water percolates freely into the waste pile, with a portion of this infiltration running off once it hits the soil beneath the waste pile. Under this scenario, CNwmu is a function of the hydrologic group (A, B, C, or D) of the soil underlying the waste pile (as the infiltration limiting media) and the cover effect of the pile itself. The hydrologic group of the WMU soil was obtained from State Soil Geographic (STATSGO) data as described in Section 7.0.

Because CNwmu is primarily subject to variability with respect to the waste pile's cover effect, three cover conditions were selected from USDA (1986) to define the range and typical cover effect of the waste pile on the underlying soil as a triangular distribution. To represent waste piles that would tend to hold water on the soil surface, minimizing runoff and maximizing infiltration, we selected "woods" in good hydrologic condition to define the minimum CNwmu value for a particular hydrologic soil group. To represent more granular waste piles with minimum water-holding capacity, we selected "gravel roads (including right-of-way)" to define the maximum CNwmu value. Small-grain, contoured, and terraced row crops, with a crop residue cover and good hydrologic condition, were used to define a moderate water-holding condition (i.e., a waste pile on a leveled base) and the central tendency CNwmu for the triangular distribution. These minimum, central, and maximum values are shown in Table 3-8 by hydrologic soil groups A, B, C, and D.

To get the SCS curve number for the waste pile, the map unit with the largest area in the WMU was used to obtain the hydrologic soil group from processed STATSGO data (see Section 7.4.2 for more details). This hydrologic soil group was used to select the correct values for CNwmu from Table 3-9, which are passed as a triangular distribution.

Table 3-9. Waste Pile Curve Numbers (CNwmu), by Hydrologic Soil Group

Hydrologic Soil Group	Curve Number (CNwmu)		
	Minimum	Central Tendency	Maximum
A	30	58	76
B	55	69	85
C	70	77	89
D	77	80	91
Source (USDA, 1986):	Woods/Good Table 2-2c	Small grain, contoured, and terraced + crop residue/Good Table 2-2b	Gravel streets and roads Table 2-2a

3.5.4 Waste Pile National Data

3.5.4.1 <u>Dust Suppression Control Efficiency (effdust)</u>. Dust suppression activities could include the watering of the waste pile to reduce dust or the application of chemical dust suppressants (U.S. EPA, 1989). A value of zero corresponds to no dust suppression activity. Although information was available about types of dust suppression control activities, no information was found on how often these activities are typically employed for Industrial D waste piles or their effectiveness. Consequently, it is assumed that dust suppression control efficiency (effdust) has a normally distributed value between 0 and 1, with a mean of 0.5 and a standard deviation of 0.3. A mean less than 0.5 (the value used for landfills) was selected because it is believed to be more likely that a facility would implement only limited dust suppression activities or that the dust suppression activities would have only limited effectiveness for waste piles, which are not typically covered the way a landfill is.

3.5.4.2 <u>Operating Life (CutOffYr)</u>. No information was found in the literature about the typical operating life of a waste pile. For purposes of the representative national data set, the operating life (CutOffYr) is assumed to be 30 yr.

3.5.4.3 <u>Vehicle Speed (vs)</u>. The mean speed that trucks travel on the waste pile unit is assumed to range from 20 to 40 km/h, based on information in Overcash and Pal (1979) for

LAUs. The vehicle speed (vs) is specified as normally distributed, with a mean of 30 km/h and a standard deviation of 6.1 km/h, again based on Overcash and Pal (1979).

3.5.4.4 USLE Cover Factor (Cwmu). For the representative national data set, it was assumed that waste piles are bare. Therefore, the universal soil loss equation (USLE) cover factor (Cwmu) for waste piles was fixed at a value of 1, indicating no cover (Wanielista and Yousef, 1993).

3.5.4.5 USLE Erosion Control Factor (Pwmu). For the representative national data set, it was assumed that no erosion control practices are implemented for the waste piles. Therefore, the USLE erosion control factor (Pwmu) for waste piles was fixed at a value of 1, indicating no erosion control (Wanielista and Yousef, 1993).

3.6 LAU Module Inputs

This section describes the approach used to develop inputs for the LAU Module. The LAU Module design is described in Section 3.6.1. Sections 3.6.2, 3.6.3, and 3.6.4 describe the development of input parameters for site-specific, site-based, and national data, respectively. For site-based variables, relationships between site-specific and site-based input parameters are identified and considered to ensure that related inputs are not randomly selected in a manner that would create physically impossible or unrealistic combinations.

Table 3-10 summarizes the data collected for LAU Module inputs. It is organized by site-specific and site-based data, which are extracted directly or calculated from Industrial D Screening Survey data, and national data, which are derived based on relationships taken from books, reports, and professional judgment.

3.6.1 LAU Module Design

3.6.1.1 Unit Configuration. Land treatment generally involves the application of wastes to an agricultural plot of land in either a liquid or semisolid form, tilling the wastes into the soil, and treatment through the biological degradation of the hazardous constituents in the soil zone. Typical land treatment unit designs include single plot, progressive plot, and rotating plot arrangements (U.S. EPA, 1989).

In single plot designs, wastes are spread uniformly over the available area. This design is typically used when applications occur only during one season or on a few specific occasions during the year. In progressive plot designs, the treatment unit is divided into smaller treatment cells, with only a single cell active at a given time. The other cells remain fallow and may be vegetated. Rotating plot designs also involve the division of the unit into smaller cells, with cells being used sequentially. The time frame during which waste is applied to a cell depends on the waste treatment requirements; however, rotation among cells is fast enough that all cells are essentially active.

For the LAU Module, the single plot design was used and the entire LAU is modeled as a single unit. Application of the module to the single plot facility design is straightforward because this design assumes that waste is applied uniformly across the entire unit area. A

Table 3-10. WMU Data Collected for the LAU Module

Variable	Units	Code	Value	Data Source
Site-Specific Variables				
WMU type	unitless	SrcType	specified "LAU"	Industrial D Screening Survey (Westat, 1987)
area of source	m^2	SrcArea	SrcArea = [total area]/[no. LAUs]	Industrial D Screening Survey (Westat, 1987); average values
Site-Based Variables				
distance vehicle travels on LAU surface	m	mt	mt = width of LAU = sqrt(SrcArea) (Equation LAU-1)	calculated from Industrial D Screening Survey; assumes a square unit
wet waste application rate	Mg/m^2-yr	Rappl	Rappl = waste quantity/SrcArea (Equation LAU-2)	calculated using data from Industrial D Screening Survey
vehicle weight	Mg	vw	vw = payload/2 + w_{empty} (Equation LAU-3) *small truck*: weight (empty): 15 Mg payload: 15 Mg *large truck*: weight (empty): 30 Mg payload: 35 Mg	best professional judgment; based on information from Overcash and Pal (1979), MRI (1990), and Caterpillar (1994); small or large truck based on Industrial D annual waste quantity
wheels per vehicle (mean)	unitless	nw	*small truck*: 6 *large truck*: 10	best professional judgment; based on information from Overcash and Pal (1979) and MRI (1990); small or large truck based on Industrial D annual waste quantity
vehicles per day (mean annual)	1/d	nv	nv = [SrcArea x Rappl]/[payload × 365.25] (Equation LAU-4)	engineering calculation; relationship of truck size to waste application rate based on best professional judgment; truck designs based on Overcash and Pal (1979) and Caterpillar (1994)
waste applications per year	1/yr	Nappl	assigned using table LAU-5	best professional judgment; based on U.S. EPA (1989), ER&T (1983), and Reed and Crites (1984)

(continued)

Table 3-10. (continued)

Variable	Units	Code	Value	Data Source
Site-Based Variables (continued)				
frequency of cultivation	unitless	fcult	calculated using table LAU-6	best professional judgment; based on quantity of waste applied per unit area and information from ER&T (1983) and U.S. EPA (1989)
frequency of surface disturbances per month (active LAU)	1/mo	fd	fd = Nappl x fcult/12 (Equation LAU-7)	calculated from the number of applications per year and the frequency of cultivation per application
SCS curve number	unitless	CNwmu	triangular distribution assigned based on hydrologic soil group	CN range for row crops, meadow (USDA, 1986) assigned based on best professional judgment; hydrologic soil groups obtained from STATSGO (see Section 7.0)
National Variables				
depth of source, depth of tilling	m	SrcDepth, zZ1WMU	constant = 0.2 m	best professional judgment, based on information in Brown et al. (1983), ER&T (1983), Martin et al. (1986), and U.S. EPA (1996b).
dust suppression control efficiency	unitless	effdust	normal distribution: minimum = 0 maximum = 1 mean = 0.5 standard deviation = 0.3	best professional judgment; based on information in U.S. EPA (1989)
fraction vegetative cover	fraction	veg	normal distribution: minimum = 0.8 maximum = 1 mean = 0.9 standard deviation = 0.1	best professional judgment; assuming unit is vegetated during operation and after closure

(continued)

Table 3-10. (continued)

Variable	Units	Code	Value	Data Source
National Variables (continued)				
operating life	yr	CutOffYr	constant = 40	best professional judgment
roughness height	cm	zruf	normal distribution: minimum = 2 maximum = 4 mean = 3 standard deviation = 0.6	best professional judgment; based on values in U.S. EPA (1989) for grassland
roughness ratio	unitless	Lc	lognormal distribution: minimum = 1 E-04 maximum = 1 E-03 mean = 3 E-04 standard deviation = 0.304	best professional judgment; based on information in U.S. EPA (1989)
vehicle speed	km/h	vs	normal distribution: minimum = 20 maximum = 40 mean = 30 standard deviation = 6.1	best professional judgment; based on information in Overcash and Pal (1979)
mode of aggregate size distribution	mm		constant = 5	conservative value from *Soil Screening Guidance* (U.S. EPA, 1996a)
USLE cover factor	unitless	Cwmu	constant = 0.08	Wanielista and Yousef (1993); assumed land use was cropland
USLE erosion control factor	unitless	Pwmu	constant = 0.50	Wanielista and Yousef (1993); assumed land use was cropland

rotating plot unit also could be modeled essentially in the same manner as a single plot operation. For the rotating plot facility, each cell would be assumed to be of equal size and operated in an identical manner, and each cell could be considered to be active throughout the year. The total waste quantity managed in the unit would be divided equally among all cells. Each cell would be modeled as receiving the same number of waste applications per year. This approach reduces the model of the rotating plot to that of a single plot design.

Modeling of a progressive plot facility would need to be based on application of the LAU Module to a series of waste cells. For the progressive plot facility, each cell could be assumed to be used sequentially. The facility could be divided into a certain number of equally sized cells, where each cell would be used for a percentage of the total operating life of the facility. For example, if the facility was divided into 10 cells and operated for 40 yr, each cell would be considered to be active for 4 yr. The operation of each cell would be considered identical. During the time a cell was not being used, that cell would be fallow and would be assumed to be growing vegetation. For modeling, it would be necessary to track how many cells had been used and to model the contaminant transport from each. For example, in a 3-cell unit operating 30 yr and modeled for 30 yr, the first cell operating would have 30 yr of contaminant transport, the second cell 20 yr, and the last cell 10 yr. The progressive plot facility would effectively reduce the area of the active unit, for modeling purposes.

Because of the difficulties in applying the LAU Module to this situation and the lack of additional module inputs that would be needed, development of input parameters based on the progressive plot facility design was not pursued. Applying the LAU Module in this manner would be problematic because the location of the individual cells relative to each other, and to the local watershed, would need to be known to determine the appropriate transport of contaminants from runoff/erosion. Further, the number of plots into which a given site would be divided, and the frequency with which plots would be used, are likely to be site-specific variables dictated by factors such as the rate of metals buildup expected in the soil. No information was found in the literature on the typical frequency of plot rotation or size. Consequently, for a progressive plot model, these parameters would have to be assumed inputs for the model.

3.6.1.2 Waste Application. The assumed method of waste delivery to the unit is important for calculating the particulate emissions due to vehicles traveling over the surface of an LAU. The waste application method in LAUs depends on the solid content of the waste (Overcash and Pal, 1979). Application methods can be divided between those for semiliquid materials (up to 15 percent solids) and those for solid or low-moisture materials (>15 percent solids). Semiliquid systems are generally applied using mobile tanks. Mobile tanks may either be tractor-hauled or truck-mounted. For the representative national data set, truck-mounted tanks are assumed to deliver any liquid or sludge wastes. Truck-mounted tanks range from 5,000 to 22,500 L, with a typical size of 9,500 L (Overcash and Pal, 1979). For low-moisture materials, truck-trailers transport and spread waste at the site. The parameter selection for the representative national data set includes model unit designs based on these waste application methods.

Liquid wastes (<8 percent solids, particle size <2.5 cm) are generally applied by either surface irrigation (tank truck) or sprinkler irrigation. Although the application of wastes to

LAUs at industrial facilities may occur through surface or sprinkler irrigation, these application methods are not the basis for the development of the LAU Module. Therefore, in the parameter selection approach, we have not attempted to simulate these types of unit designs.

3.6.2 LAU Site-Specific Data

Site-specific data for LAUs were obtained from the Industrial D Screening Survey (Westat, 1987). This includes total area, number of LAUs at each site, and total 1985 annual waste quantity. Average values were calculated for use in the representative national data set by dividing the total area and the total annual waste quantity by the number of units at each site. Appendix 3A shows raw data from the Industrial D Screening Survey for the 201 Industrial D sites included in the representative national data set.

In some cases, the LAU annual waste quantity was screened due to unrealistic values or missing data. Replacement values were calculated under two conditions: (1) if surface area data were reported for a given LAU but the waste quantity was not provided or (2) if the calculated application rate (based on waste quantity and area) exceeded the upper bound set at 10,000 tons/acre-yr (which is equivalent to 2.24 Mg/m^2-yr). Questionable data were screened following EPACMTP methodology (U.S. EPA, 1997):

> The land application managed waste data were screened by constraining unit application rate to be less than 10,000 tons/acre/year to eliminate unrealistic values. The application rate was calculated by dividing the waste managed in 1985 by the site acreage. (The upper bound was derived by assuming a maximum application rate of 200 dry tons/acre/year with a 2% solids content.)

Of the 352 LAUs (reporting surface area), 8 facilities did not provide data on annual waste quantity. Waste quantities were replaced for 12 other facilities because the calculated application rate exceeded the upper bound. The procedure to replace values was consistent with EPACMTP methodology (U.S. EPA, 1997):

> Missing and screened values were replaced by random realizations from the joint area/volume probability distribution or the corresponding marginal distributions depending on where both or only one of either the waste volume or area observation was missing or screened. The joint distribution was assumed to be lognormal and was derived from the non-missing unit area/volume pairs that met the application rate constraint.

In order to calculate replacement values for the screened and missing annual waste quantities, first a statistical regression of log (average 1985 waste quantity) versus log (average surface area) was performed on the facilities with a known annual waste quantity. The regression yielded an equation for a best fit line through the known values. This equation gave the waste quantity as a function of the area, so the missing or screened waste quantities could be estimated based on the known areas. To provide a more probabilistic sampling of average waste quantities, and because the known quantities seemed to be in a limited range (± 1) above and below the best-fit line (with some outliers), a positive or negative random number was generated within that range. This random number was then added to the calculated log (average waste quantity) to replace each missing waste quantity with a random value that was reasonable with respect to LAU area. Figure 3-3 shows the regression plot, including the replaced (random waste quantity) values for Industrial D LAUs.

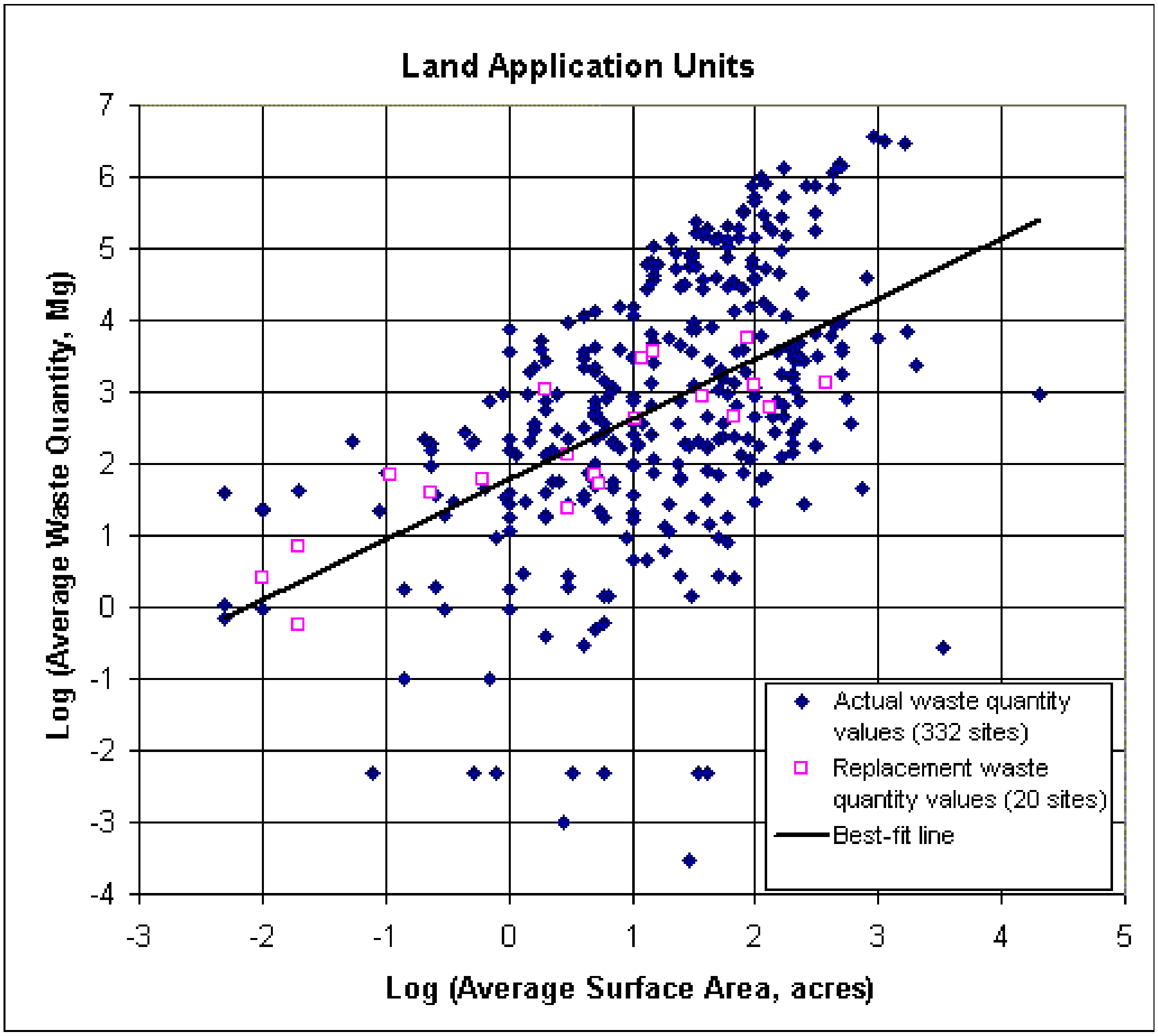

Figure 3-3. Correlation of waste quantity to area for LAUs.

3.6.3 LAU Site-Based Data

Site-based data are derived from Industrial D data (e.g., average area and width of the LAU), using relationships based on the published literature and best engineering judgment.

3.6.3.1 <u>Distance Vehicle Travels on LAU Surface (mt)</u>. The representative national data set assumes that WMUs are square. In reality, the shape of LAUs is likely to be dictated by the available land; however, because data on length/width ratios in LAUs are absent from the literature, assuming a square unit is reasonable and allows the various models to be applied appropriately to the LAU. The distance traveled over the LAU (mt) by the truck is assumed to be equal to the width of the WMU, as given by Equation LAU-1:

$$\text{mt (m)} = \text{width (m)} = \sqrt{\text{area (m}^2)} \qquad \text{(LAU-1)}$$

3.6.3.2 <u>Wet Waste Application Rate (Rappl)</u>. The wet waste application rate (Rappl) is calculated as the average annual quantity of waste managed at the facility divided by the average LAU area as follows:

$$R_{appl}(\text{Mg/m}^2 - \text{yr}) = \frac{\text{waste quantity (Mg/yr)}}{\text{area (m}^2)} \qquad \text{(LAU-2)}$$

3.6.3.3 <u>Vehicle Weight (vw), Payload, and Number of Wheels (nw)</u>. Two typical truck sizes were developed for this analysis: small and large. Data on typical truck payloads (and number of wheels per truck) were obtained from Overcash and Pal (1979) and MRI (1990). Data for determining the ratio of total to empty vehicle weight were obtained from Caterpillar (1994).

A small truck is assumed to have 6 wheels and a full weight of 30 Mg (15 Mg vehicle weight empty plus 15 Mg payload). The vehicle weight estimate is based on a payload size of 10 m^3 (roughly midrange for tank trucks in Overcash and Pal, 1979), a waste bulk density of about 1.5 Mg/m^3, and a ratio of weight loaded to weight unloaded of about 2.

A large truck is assumed to have 10 wheels and a full weight of 65 Mg (30 Mg vehicle weight empty plus 35 Mg payload). This vehicle weight estimate is based on a payload size of about 23 m^3 (the upper end of the tank truck sizes in Overcash and Pal, 1979), a waste density of about 1.5 Mg/m^3, and a ratio of weight loaded to weight unloaded of about 2.2.

The average number of vehicles used per waste application was not available from the literature. Instead, the average number of vehicles was calculated by assigning a truck size to the facility based on the amount of waste managed in the unit annually (i.e., waste quantity). For units managing less than 30,000 Mg/yr, a small truck is assumed. For units managing 30,000 Mg/yr or more, a large truck is assumed. Depending on the quantity of waste managed at the LAU, the appropriate truck payload is used in Equation LAU-4.

The vehicle weight is used in the particulate emission calculations. A full truck is assumed to drive onto the unit, dump its load while driving across the unit, and then exit empty. The vehicle weight is the average of its weight full and empty. The weight of the vehicle depends on the size of the vehicle (large or small) and the vehicle payload and is expressed as follows:

$$\text{vw (Mg)} = \frac{w_{full}(\text{Mg}) + w_{empty}(\text{Mg})}{2} = \frac{\text{payload (Mg)}}{2} + w_{empty}(\text{Mg}) \qquad \text{(LAU-3)}$$

where

vw	=	vehicle weight for a small or large truck (Mg)
payload	=	carrying capacity of the truck (Mg)

w_{full} = vehicle weight when full (Mg) = w_{empty} (Mg) + payload (Mg)
w_{empty} = vehicle weight when empty (Mg).

3.6.3.4 <u>Vehicles per Day (nv)</u>. The average number of vehicles per day (nv) is determined by the average area of the LAU, the average annual waste application rate (Rappl from Equation LAU-2), and the carrying capacity (or payload) of the truck. The relationship is expressed as follows:

$$nv(1/d) = \frac{area(m^2) \times R_{appl}(Mg/m^2 - yr)}{payload(Mg) \times 365.25(d/yr)} \qquad \text{(LAU-4)}$$

3.6.3.5 <u>Waste Applications per Year (Nappl)</u>. The following table shows how to determine the number of waste applications per year (Nappl) based on the annual waste quantity managed at the LAU. It was developed to keep the estimated number of applications at less than 100 per yr, based on information about typical applications per year found in U.S. EPA (1989), Environmental Research & Technology (ER&T) (1983), and Reed and Crites (1984). According to U.S. EPA (1989), the range for refineries is typically 2 to 52 applications per yr.

Annual Waste Quantity (Mg/yr)	Waste Applications per Year, Nappl (1/yr)
<1500	Waste quantity/15
>=1,500, <15,000	Waste quantity/150
>=15,000, <150,000	Waste quantity/1,500
>=150,000	Waste quantity/15,000

(LAU-5)

3.6.3.6 <u>Frequency of Cultivation (fcult)</u>. The frequency of cultivation (fcult) is determined based on the quantity of waste applied per unit area. In general, more cultivation per waste application is required for waste applied at a greater quantity per unit area (ER&T, 1983). According to U.S. EPA (1989), there are 1 to 5 cultivation events per application. The frequency of cultivation is calculated based on the following table, which was developed based on best professional judgment.

Annual Waste Application Rate ($Mg/m^2/yr$)	Frequency of Cultivation, f_{cult} (cultivations per waste application)
<0.01	1
>=0.01, <0.1	2
>=0.1, <1.0	3
>=1.0, <10.0	4
>=10.0	5

(LAU-6)

3.6.3.7 Frequency of Surface Disturbances per Month (fd). A disturbance is defined as an action that results in the exposure of fresh surface material. This would occur whenever material is added to the surface or the surface is tilled. The frequency of surface disturbances per month (fd) equals the number of applications of waste per month multiplied by the number of cultivation events per application, as follows:

$$fd(1/mo) = \frac{N_{appl}(1/yr) \times f_{cult}}{12\,(mo/yr)} \qquad \text{(LAU-7)}$$

where

fd = frequency of surface disturbances per month (1/mo)
N_{appl} = number of waste applications per year (1/yr) (from table LAU-5)
f_{cult} = average frequency of cultivation of the plot, per application (from table LAU-6).

3.6.3.8 SCS Curve Number (CNwmu). The Soil Conservation Survey (SCS) curve number for the LAU (CNwmu) was based on the site-specific hydrologic soil group and the assumption that during operation and post-closure, the LAU would be actively cultivated with row crops, pasture, or meadow. To represent the potential variability in CNwmu under cultivation, a triangular distribution, based on three cover conditions, was selected from USDA (1986) and used to define the range and typical cover effect of agricultural cultivation. "Meadow – continuous grass, protected from grazing and generally mowed for hay" was used to represent conditions leading to minimum runoff and maximum infiltration, or minimum CNwmu, for a particular hydrologic soil group. To represent maximum CNwmu, or maximum runoff and minimum infiltration, straight row crops in poor hydrologic condition were used. Contoured row crops, with a crop residue cover and good hydrologic condition were used as the central tendency CNwmu for the triangular distribution, to represent a moderate water holding condition. These minimum, central and maximum values are shown in Table 3-10 by hydrologic soil groups A, B, C, and D.

To get the SCS curve number for the LAU, the map unit with the largest area in the WMU was used to obtain the hydrologic soil group from processed STATSGO data (see Section 7.4.2 for more details). This hydrologic soil group was used to select the correct values for CNwmu from Table 3-11, which were sent to the LAU Module as the parameters of a triangular distribution.

3.6.4 LAU National Data

3.6.4.1 Depth of Tilling (SrcDepth, zZ1WMU). The till depth is generally a function of the equipment used to conduct the tilling operation. Because this variable was sent both in the site layout (SrcDepth) and LAU (zZ1WMU) data groups, it was necessary to fix the value to ensure that the same value would be used for both variables. A tilling depth of 0.20 m was selected as a typical till depth based on a literature review (Brown et al., 1983; ER&T, 1983; Martin et al., 1986; U.S. EPA, 1996b). The limited range for this variable found in these data sources also supports the use of a constant value.

Table 3-11. LAU Curve Numbers (CNwmu), by Hydrologic Soil Group

Hydrologic Soil Group	Curve Number (CNwmu)		
	Minimum	**Central Tendency**	**Maximum**
A	30	64	72
B	58	74	81
C	71	81	88
D	78	85	91
Source (USDA, 1986):	Meadow Table 2-2c	Contoured row crops + crop residue/Good Table 2-2b	Straight row crops/Poor Table 2-2b

3.6.4.2 <u>Dust Suppression Control Efficiency (effdust)</u>. Dust suppression activities might include watering the LAU to reduce dust or applying chemical dust suppressants (U.S. EPA, 1989). A value of zero corresponds to no dust suppression activity. Although information was available about types of dust suppression control activities, no information was found on how often these activities are typically employed or their effectiveness. Consequently, it is assumed that dust suppression control efficiency (effdust) has a normally distributed value between 0 and 1, with a mean of 0.5 and a standard deviation of 0.3. The mean value for dust suppression control efficiency for the LAU was set higher than that for the waste pile because the application of liquid waste in the LAU can suppress dust.

3.6.4.3 <u>Fraction Vegetative Cover (veg)</u>. During LAU operation, fraction vegetative cover (veg) is assumed to be between 0.8 and 1, reflecting operation of the unit as agricultural cropland. The fraction vegetative cover is specified as a normal distribution, with a mean of 0.9 and a standard deviation of 0.1.

3.6.4.4 <u>Operating Life (CutOffYr)</u>. For the representative national data set, LAU operating life was set at a constant value of 40 yr.

3.6.4.5 <u>Roughness Height (zruf)</u>. This factor is the height aboveground at which the wind speed becomes zero (U.S. EPA, 1989). The range is 0.1 to 1,000 cm for snow to urban settings. U.S. EPA (1989) provides some values for the roughness height for various sites in Arizona and for industrial aggregates, as well as a chart of values for different settings. The roughness height for a closed LAU is assumed to be normally distributed from 2 to 4 cm (corresponding to grassland), with a mean of 3 cm and a standard deviation of 0.6 cm.

3.6.4.6 <u>Roughness Ratio (Lc)</u>. This factor is the ratio of the silhouette area of the roughness elements (>1 cm) in the soil to the total bare loose soil. The roughness ratio (Lc) can range from 0 to 0.01 (U.S. EPA, 1989). Lc was assumed to be lognormally distributed, with a minimum of 1×10^{-4}, a maximum of 1×10^{-3}, a mean of 3×10^{-4}, and a standard deviation of 0.304. Higher Lc values ($>2\times10^{-4}$) increase the threshold wind speed for the onset of wind erosion (which means lower particulate emissions due to wind erosion). Therefore, assuming a value for Lc of 1×10^{-4} is conservative with respect to particulate emissions.

3.6.4.7 Vehicle Speed (vs). Vehicle speed is the mean speed that trucks travel on the LAU. For surface spreading, a range of 20 to 40 km/h is representative (Overcash and Pal 1979). Vehicle speed (vs) is assumed to have a normal distribution from 20 to 40 km/h with a mean of 30 km/h and a standard deviation of 6.1 km/h.

3.6.4.8 Mode of Aggregate Size Distribution (asdm). This parameter is the mode value of the size of soil aggregates in an LAU. Because little data were available on this parameter, a conservative value of 0.5 mm is assumed for this parameter based on the *Soil Screening Guidance: Technical Background Document* (U.S. EPA, 1996a).

3.6.4.9 USLE Cover Factor (Cwmu) and Erosion Control Factor (Pwmu). For the representative national data set, it was assumed that the LAU is maintained as cropland. Therefore, the USLE cover factor (Cwmu) was fixed at a value of 0.08 and the erosion control factor (Pwmu) was fixed at a value of 0.50 (Wanielista and Yousef, 1993).

3.7 Surface Impoundment Module Inputs

This section describes the approach used to develop inputs for the Surface Impoundment Module. The module design is described in Section 3.7.1. Sections 3.7.2 through 3.7.4 describe the development of input parameters for site-specific, site-based, and national data, respectively. Relationships between site-specific and site-based input parameters are identified and considered to ensure that related inputs are not randomly selected in a manner that would create physically impossible or unrealistic combinations.

Table 3-12 summarizes the data collected for Surface Impoundment Module inputs. It is organized by site-specific and site-based data, which are extracted directly or calculated from Industrial D Screening Survey data, and national data, which are derived based on relationships taken from books, reports, and professional judgment.

3.7.1 Surface Impoundment Module Design

A surface impoundment is an excavation or diked area typically used for the treatment, storage, or disposal of liquids or sludges containing free liquids. Liquids and solids typically separate in a surface impoundment by gravity settling. Liquids from surface impoundments are removed by draining, evaporation, or flow through an outlet structure. Accumulated solids are removed by dredging during impoundment operation or at the time of closure.

There are more than 180,000 surface impoundments in the United States (Hartley, 1992). Nearly 30,000 are used by industry, including chemical manufacturers, food processors, oil refineries, primary and fabricated metals, paper plants, and other commercial facilities.

For the representative national data set, surface impoundments were categorized depending on the waste composition, waste generation rate, and purpose of impoundment. Based on their purpose, the three generic impoundment types are storage, disposal, and treatment. Table 3-13 summarizes the distribution of surface impoundment applications.

Table 3-12. WMU Data Collected for the Surface Impoundment Module

Variable	Units	Code	Value	Data Source
Site-Specific Variables				
WMU type	unitless	SrcType	specified "SI"	Industrial D Screening Survey (Westat, 1987)
area of source	m^2	SrcArea	SrcArea = [total area]/[no. surface impoundments]	Industrial D Screening Survey (Westat, 1987); average values
Site-Based Variables				
depth of source	m	d_wmu, SrcDepth	capacity/[SrcArea × bulk density] (Equation SI-1)	derived from Industrial D Screening Survey; assumed bulk density of waste = 1.09577 g/cm^3; depth constraint 0.3 to 46 m (1 to 150 ft)
volumetric influent flow rate	m^3/s	Q_wmu	Q_wmu = waste quantity/[365.25 (d/y) x 86,400 (s/d) x bulk density] (Equation SI-2)	derived from Industrial D Screening Survey; assumed bulk density of waste = 1.0 g/cm^3
fraction of surface impoundment occupied by sediments	fraction	d_setpt	d_wmu < 1.5: d_setpt = 0.2 d_wmu >= 1.5 and <5: d_setpt = (d_wmu - 1.2)/d_wmu d_wmu >= 5: d_setpt = 0.76	best professional judgment; Tchobanoglous (1979)
impellers/aerators (number)	unitless	n_imp	SrcArea > 1,600 m^2: n_imp = integer(SrcArea/1,600) + 1 SrcArea < 1,600 m^2: n_imp = integer(SrcArea/160) + 1	U.S. EPA (1990); maximum number of impellers/aerators is 66 (4,950 hp)

(continued)

Table 3-12. (continued)

Variable	Units	Code	Value	Data Source
Site-Based Variables				
impellers/aerators (total power)	hp	Powr	SrcArea > 1,600 m^2: Powr = n_imp x 75 SrcArea < 1,600 m^2: Powr = n_imp x 7.5	U.S. EPA (1990); total power is assumed not to exceed 5,000 hp
turbulent area	m^2	—	turbulent area = n_imp x 5.22 x Powr	U.S. EPA (1990); assumed 5.22 m^2/hp turbulent area
fraction surface area turbulent	fraction	F_aer	F_aer = turbulent area/SrcArea	
National Variables				
biologically active solids/total solids (ratio)	unitless	kba1	uniform distribution: minimum = 0.7 maximum = 0.9	Tchobanoglous (1979)
biomass yield	g/g	bio_yield	uniform distribution: minimum = 0.4 maximum = 0.8	Tchobanoglous (1979)
digestion (sediments)	1/s	k_dec	uniform distribution: minimum = 4.6 E-07 maximum = 8.7 E-07	Tchobanoglous (1979)
economic life of a tank/surface impoundment	yr	EconLife	constant = 50	best professional judgment
impeller diameter	cm	d_imp	constant = 61	U.S. EPA (1990)
impeller speed	rad/s	w_imp	constant = 126	U.S. EPA (1990)
number of economic lifetimes	unitless	NumEcon	constant = 1.0	best professional judgment

(continued)

Table 3-12. (continued)

Variable	Units	Code	Value	Data Source
National Variables				
oxygen transfer correction factor	unitless	O2eff	uniform distribution: minimum = 0.80 maximum = 0.85	Tchobanoglous (1979)
oxygen transfer factor	lb O_2/h-hp	J	constant = 3	Tchobanoglous (1979)
saturated hydraulic conductivity (sediment layer)	m/s	hydc_sed	uniform distribution: minimum = 1 E-9 maximum = 1 E-6	best professional judgment

Table 3-13. Distribution of Surface Impoundment Applications

	Storage Percentage	Disposal Percentage	Treatment Percentage
Agricultural	55	26	19
Municipal	5	31	64
Industrial	17	31	52
Mining	18	27	56
Oil and gas	29	67	4

Source: Hartley, 1992.

3.7.2 Surface Impoundment Site-Specific Data

Site-specific data for surface impoundments were obtained from the Industrial D Screening Survey (Westat, 1987). The data include total area, number of surface impoundments at each site, total capacity, and total 1985 annual waste quantity. Average values were calculated for use in the representative national data set by dividing each of the parameters by the number of units at each site. Appendix 3A shows raw data from the Industrial D Screening Survey (including replacement values) for the 201 Industrial D sites included in the representative national data set.

In accordance with previous EPA modeling efforts using the Industrial D Screening Survey, surface impoundment capacities were screened from the Industrial D data when either the capacity was missing or the depth constraint was violated. As with landfills, the unit depth was calculated by dividing the unit capacity by the unit area. The depth constraint was described by EPACMTP documentation as follows (U.S. EPA, 1997):

> The surface impoundment volume data were screened by constraining the calculated unit depth to be between one and 150 feet in order to eliminate unrealistic values.

Some 1,926 Industrial D surface impoundment facilities reported surface area. Missing waste quantity values were replaced for 57 of these facilities. Replacement capacity values were calculated for 262 of the facilities with either missing or screened capacities. The procedures to replace waste quantity and capacity are conditioned on area, as described for other WMU types, and are consistent with EPACMTP methodology (U.S. EPA, 1997).

In order to calculate replacement values for the screened and missing annual waste quantities, first a statistical regression of log (average annual waste quantity) versus log (average surface area) was performed on the facilities with known quantities. The regression yielded an equation for a best fit line through the known values. This equation gave the waste quantity as a function of area, so the missing or screened waste quantities could be estimated based on the known areas. To provide a more probabilistic sampling of average waste quantities, and because the known quantities seemed to be in a limited range (± 1) above and below the best-fit line (with some outliers), a positive or negative random number was generated within that range. This random number was then added to the calculated log (average waste quantity) to replace each missing waste quantity with a random value that was reasonable with respect to the surface impoundment area. Figure 3-4 shows the regression plot, including the replaced (random waste quantity) values, for surface impoundments.

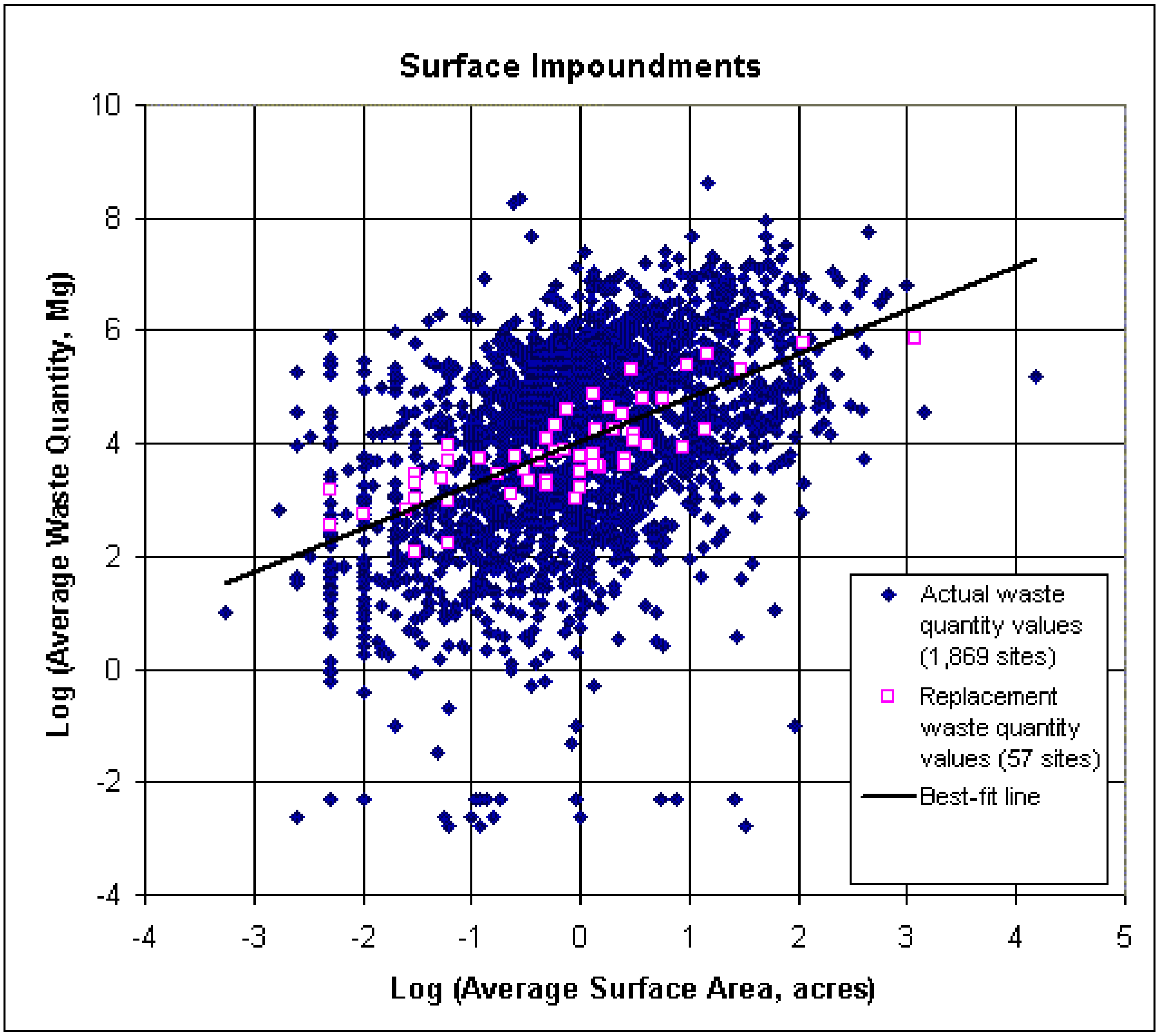

Figure 3-4. Correlation of waste quantity to area for surface impoundments.

To calculate replacement values for capacity, first a statistical regression of log (average total capacity) versus log (average surface area) was performed on the facilities with known capacities. The regression yielded an equation for a best-fit line through the known values. This equation gave the capacity as a function of area, so the missing or screened capacities could be estimated based on the known areas. To provide a more probabilistic sampling of average capacities, and because the known capacities seemed to be in a limited range (± 0.8) above and below the best-fit line (with some outliers), a positive or negative random number was generated within that range and added to the calculated log (average total capacity) to replace each missing capacity with a random value that was reasonable with respect to the surface impoundment area.

This value was then used to calculate depth as described above. Figure 3-5 shows the regression plots, including the replaced (random capacity) values, for surface impoundments.

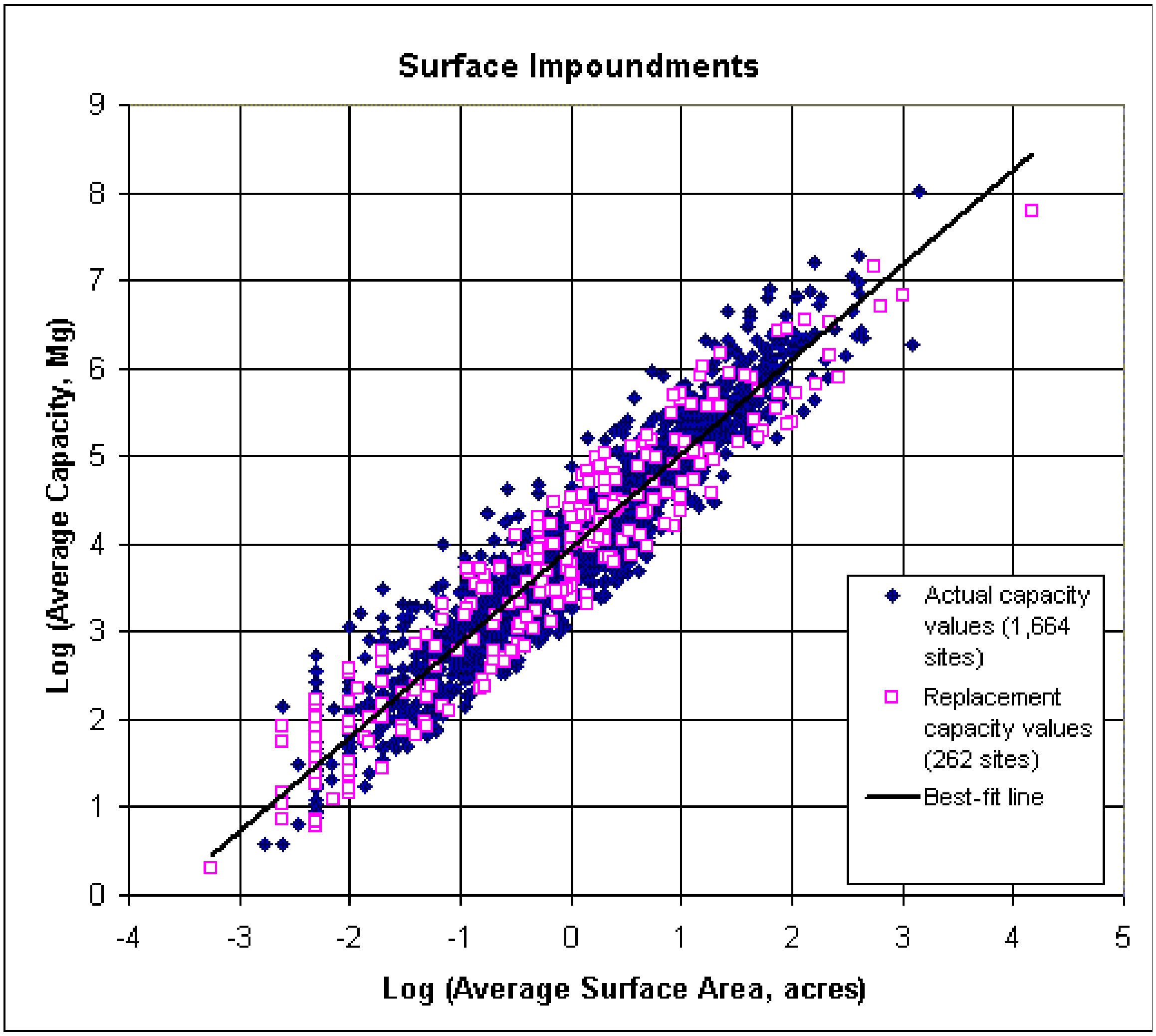

Figure 3-5. Correlation of total capacity to area for surface impoundments.

3.7.3 Surface Impoundment Site-Based Data

Surface impoundment variables related to site-specific surface impoundment area, capacity, or annual waste quantity were calculated as described below.

3.7.3.1 <u>Depth of Surface Impoundment (d_wmu, SrcDepth)</u>. Surface impoundment depth (d_wmu or SrcDepth) was calculated consistent with previous EPA modeling efforts using the Industrial D capacity and area data (U.S. EPA, 1997). The bulk density used for surface impoundment was 1.0 g/cm^3. A range of 0.3 to 46 m (1 to 150 ft) was set as the depth constraint.

$$\text{depth (m)} = \frac{\text{SI capacity (Mg)} \times 1{\times}10^6\ \text{g/Mg}}{\text{area (m}^2) \times \text{bulk density (g/cm}^3) \times (100\ \text{cm/m})^3} \qquad \text{(SI-1)}$$

3.7.3.2 <u>Volumetric Influent Flow Rate (Q_wmu)</u>. Volumetric influent flow rate (Q_wmu) is calculated based on the annual waste quantity from the Industrial D Screening Survey and an assumed bulk density of 1.0 Mg/m^3. Values ranged from 1×10^{-20} to 10 m^3/s. It was calculated as follows:

$$Q\_wmu\,(m^3/s) = \frac{\text{waste quantity (Mg/yr)}}{365.25\,(d/yr) \times 86{,}400\,(s/d) \times \text{bulk density}\,(Mg/m^3)} \qquad \text{(SI-2)}$$

3.7.3.3 <u>Fraction of Unit Occupied by Sediments (d_setpt)</u>. To calculate the fraction of unit occupied by sediments (d_setpt), the following formula was developed based on best professional judgment, as follows:

For depths less than 1.5 m, d_setpt = 0.2
For depths less than 5 m, d_setpt = (depth - 1.2)/(depth)
For depths greater that 5 m, d_setpt = 0.76 (maximum value).

For depths less than 1.5 m, it is assumed the unit is cleaned whenever more than 20 percent of the unit depth is filled with sediment. For depths greater than 5 m, it is assumed the unit is cleaned whenever more than 76 percent of the unit is filled with sediment. For depths between 1.5 and 5 m, the set point is calculated as the percentage required to keep at least 1.2 m of clean depth. These values are based on engineering judgment and Tchobanoglous (1979).

3.7.3.4 <u>Impellers/Aerator Number (n_imp), Total Horsepower (Powr), and Fraction Surface Area Turbulent (F_aer)</u>. It is assumed that a one hp motor will agitate an area of 5.22 m^2 (U.S. EPA, 1990). Based on this assumption, we can calculate the total turbulent area using a 75- or 7.5-hp motor (turbulent area = ~392 m^2 for 75-hp motor). Typically, the turbulent area for a surface impoundment is about 25 percent of the total area of the unit (U.S. EPA, 1990). Therefore, a 75-hp motor will aerate about 25 percent of a 1,600 m^2 surface impoundment (392/1,600 = ~0.25). The number of impellers is taken to be equal to the number of motors. Two motor sizes were assumed: 7.5 hp and 75 hp. The smaller motor was assumed for smaller impoundments (area <1,600 m^2), while the larger motor was assumed for larger impoundments (area >=1,600 m^2).

- The number of impellers (n_imp) is calculated as follows:

  If source area >1,600 m^2, then n_imp = Integer [source area (m^2)/1,600 m^2] + 1.
  If source area <1,600 m^2, then n_imp = Integer [source area (m^2)/160 m^2] + 1.

- Total impeller power (Powr, hp) = n_imp × power per impeller (hp).

  If source area >1,600 m^2, then power per impeller = 75 hp.
  If source area <1,600 m^2, then power per impeller = 7.5 hp.

- Assuming 5.22 m^2/hp turbulent, turbulent area (m^2) = Powr (hp) × 5.22 (m^2/hp).

- Fraction turbulent area (F_aer) = turbulent area (m^2)/source area (m^2).

Total power is assumed not to exceed 5,000 hp. From the above calculations, therefore, the maximum number of impellers/aerators is 66 (4,950 hp).

3.7.4 Surface Impoundment National Data

Noncorrelated surface impoundment variables included in the national data tables are described below.

3.7.4.1 Ratio of Biologically Active Solids to Total Solids (kba1). Values for the ratio of biologically active solids to total solids were assumed to be uniformly distributed between 0.7 and 0.9. The range is based on data from Tchobanoglous (1979).

3.7.4.2 Biomass Yield (bio_yield). Values for biomass yield were assumed to vary uniformly, from 0.4 to 0.8 g/g. This is based on a range of 0.4 to 0.8 mg VSS/mg of biological oxygen demand for a 5-day test (BOD_5), reported by Tchobanoglous (1979).

3.7.4.3 Digestion Rate (Sediments) (k_dec). Values for sediment digestion rate were assumed to be uniformly distributed between 4.6×10^{-7} s^{-1} and 8.7×10^{-7} s^{-1}. This is based on a range of 0.04 to 0.075 d^{-1} given for the parameter K_d (the endogenous decay coefficient) in Table 9-7 of Tchobanoglous (1979).

3.7.4.4 Economic Life of Surface Impoundment (EconLife). The economic life of a surface impoundment was assumed to be 50 yr.

3.7.4.5 Impeller Diameter (d_imp). The impeller diameter was fixed at 61 cm, based on U.S. EPA (1990).

3.7.4.6 Impeller Speed (w_imp). The value for impeller speed was fixed at 126 rad/s. This is based on data from U.S. EPA (1990).

3.7.4.7 Number of Economic Lifetimes (NumEcon). The number of economic lifetimes was fixed at 1.

3.7.4.8 Oxygen Transfer Correction Factor (O2eff). Values for the oxygen transfer factor were assumed to be uniformly distributed between 0.80 and 0.85. The recommended range is based on data from Tchobanoglous (1979).

3.7.4.9 Oxygen Transfer Factor (J). Values for the oxygen transfer factor were fixed at 3.0 lb O_2/hp h. This is the median of the recommended range of 2.0 and 4.0 O_2/hp h based on data from Tchobanoglous (1979).

3.7.4.10 Saturated Hydraulic Conductivity of Sediment Layer (hydc_sed). The value of this parameter was assumed to be uniformly distributed between 1×10^{-9} and 1×10^{-6} m/s, based on engineering judgment that the sediment layer will be similar to a compacted soil.

3.8 Aerated Tank Module Inputs

This section describes the approach used to develop inputs for the Aerated Tank Module. The Aerated Tank Module design is described in Section 3.8.1. Section 3.8.2 describes the use of tank data from the TSDR Survey (U.S. EPA, 1987) to derive correlated model input variables. Section 3.8.3 describes the collection of other, noncorrelated, nationally specified input parameters. These data were derived based on relationships taken from books, reports, and professional judgment. Table 3-14 summarizes the data collected for Aerated Tank Module inputs.

3.8.1 Aerated Tank Module Design

Tanks are used to treat and/or store a variety of waste materials. Tanks may be enclosed, covered, or open to the atmosphere. This analysis focused on treatment tanks that were open to the atmosphere and had some agitation of material contained in the tank. Two levels of agitation (or aeration) were considered. Tanks that actively mix the liquid surface for the purpose of aeration (transferring oxygen from the atmosphere into the liquid) were classified as HI aeration because these units have a high degree of turbulence by design. Tanks that are likely to have mixing devices used with chemical additions or other purposes were classified as LO aeration. These tanks have convective currents and some degree of turbulence that increases volatile losses, but they are not designed specifically to enhance air-liquid mass transfer. Key parameters for any tank design are tank capacity and flow rate (which fixes the hydraulic retention time). For treatment tanks, the number, type, and power input to the aerators/mixers are important design parameters. For biological treatment tanks, the concentration of active biomass and the overall oxygen transfer rate (which is dependent on the aerator characteristics as well as the surface area to volume ratio) are also key design parameters.

Treatment tanks can be elevated (bottom of tank above ground level), on the ground (bottom of tank at ground level), or in-ground (bottom of tank below ground level). As the tank volume increases, so does the likelihood that the tank is on or in the ground. The elevation of the tank with respect to the ground level impacts the release height of the volatile emissions and the subsequent dispersion characteristics.

As described in Section 2.0, an aerated tank is assumed to be present at every facility that has a surface impoundment for the representative national data set. This is based on the assumption that surface impoundments are an indication that a facility manages liquid wastes and that tanks are likely to be present at such facilities. During the execution of the 3MRA modeling system, tanks are randomly selected for placement at aerated tank sites from a correlated data set of model tanks developed from the 624-tank TSDR database described in Section 3.2.2. The following section (Section 3.8.2) describes how this data set was developed.

Table 3-14. WMU Data Collected for the Aerated Tank Module

Variable	Units	Code	Value	Data Source
Site-Specific (Correlated) Variables				
aerated tank index	unitless	ATIndex	uniform distribution from 1 to 624 (number of tanks in national tank data set)	
volumetric flow rate (tank)	m^3/s	Q_wmu	converted from gallons	TSDR Survey (U.S. EPA, 1987)
depth (liquid)	m	d_wmu	calculated using tank capacity and HI/LO aeration designations; uses a random variation on calculated depths (Equation AT-1 and Section 3.8.2.3)	derived from TSDR Survey
area of source	m^2	SrcArea	calculated based on tank volume and projected tank depth (d_wmu)	derived from TSDR Survey
fraction surface area-turbulent	fraction	F_aer	assigned depending on HI/LO aeration designation HI aeration, normal distribution: minimum = 0 maximum = 1 mean = 0.75 standard deviation = 0.1 LO aeration, normal distribution: minimum = 0.2 maximum = 0.8 mean = 0.50 standard deviation = 0.2	derived from TSDR Survey

(continued)

Table 3-l4. (continued)

Variable	Units	Code	Value	Data Source
Site-Specific (Correlated) Variables				
impellers/aerators (total power)	hp	Powr	assigned depending on HI/LO aeration designation (minimum = 0.25) HI aeration, normal distribution: 90 percent between 80 and 150 hp per million gallons of tank volume LO aeration, normal distribution: 90 percent between 15 and 45 hp per million gallons of tank volume	Tchobanoglous (1979), Adams and Eckenfelder (1974) and Water Pollution Control Federation (WPCF, 1988); minimum total power based on minimum size of commercially available mixers for containers holding 55 gal or more
impellers/aerators (number)	unitless	n_imp	Powr ≤25 hp: n_imp = 1 25 hp < Powr < 80 hp: randomly pick 1 or 2 (equal probability) Powr ≥80 hp: Integer (Powr/[random number between 60 and 100])	Adams and Eckenfelder (1974), Water Pollution Control Federation (WPCF, 1988)
National Variables				
biologically active solids/total solids (ratio)	unitless	kba1	uniform distribution: minimum = 0.7 maximum = 0.9	Tchobanoglous (1979)
biomass yield	g/g	bio_yield	uniform distribution: minimum = 0.4 maximum = 0.8	Tchobanoglous (1979)
digestion (sediments)	1/s	k_dec	uniform distribution: minimum = 4.6E-07 maximum = 8.7E-07	Tchobanoglous (1979)

(continued)

Table 3-l4. (continued)

Variable	Units	Code	Value	Data Source
National Variables				
economic life of AT/SI	yr	EconLife	constant = 20	best professional judgment
fraction of tank occupied by sediments (max.)	fraction	d_setpt	constant = 0.3	best professional judgment
impeller diameter	cm	d_imp	constant = 61	U.S. EPA (1990)
impeller speed	rad/s	w_imp	constant = 126	U.S. EPA (1990)
number of economic lifetimes	unitless	NumEcon	constant = 2.5	best professional judgment
oxygen transfer correction factor	unitless	O2eff	constant = 0.83	Tchobanoglous (1979)
oxygen transfer factor	lb O_2/h-hp	J	constant = 3.0	Tchobanoglous (1979)

3.8.2 Aerated Tank Correlated Data

Correlated tank data include size-related variables directly extracted or derived from the TSDR database described in Section 3.2.2. These variables are passed to the system as a data set of 624 model tanks. Correlated tank data and related parameters used in their derivation (such as aeration level, tank size, and tank capacity) are presented in Appendix 3B-3. As described in Section 3.3.3, when the 3MRA modeling system models an aerated tank site, one of these tanks is randomly selected and placed at the site. To avoid placing unreasonably large tanks at sites with small surface impoundments, tank selection is constrained so that the selected tank is no larger than the average surface impoundment area at the facility in question (i.e., the data set is resampled when this occurs).

3.8.2.1 Aerated Tank Index (ATIndex) and Maximum Source Area (MaxSrcArea). The ATIndex and MaxSrcArea are used by the 3MRA modeling system site definition processor in the selection of a tank to model at a facility. ATIndex is an integer with a uniform distribution from 1 to 624 that is randomly sampled to provide the tank to be modeled at a site. Each correlated tank variable is indexed on the ATIndex to allow the system to pick a consistent set of correlated values.

MaxSrcArea is simply the average surface impoundment area (SrcArea) for the site in question (see Section 3.7.2).

3.8.2.2 Tank Throughput (Q_wmu). Values for tank throughput in the original TSDR Survey database were in units of gallons per year. These values were converted into units of cubic meters per second (m^3/s) based on the assumption of 8,766 h/yr operation.

3.8.2.3 Preliminary Tank Depth. The preliminary tank depth is used to estimate tank depth for the model as described in Section 3.8.2.4.

In 1985 and 1986, Research Triangle Institute (RTI) conducted numerous site visits to aerated treatment systems. Data extracted from site visit test reports is presented in Appendix 3B, Table 3B-2. Based on these data and the addition of a cubic 55-gal tank and a 3-million-gal/32-ft-deep tank (based on vendor information), the following log expression was derived:

$$\text{depth, m} = 10^{[0.1358 \times \log(\text{tank capacity, m}^3) + 0.2236]} \qquad \text{(AT-1)}$$

Using this expression, 55 gal tanks (the smallest tanks in the database) are approximately 4.4 ft tall and have a diameter less than 18 in. Consequently, for small tanks, a cubed-shaped tank was used as the central tendency value (i.e., depth = capacity$^{0.333}$). At a tank size of approximately 10 m^3, Equation AT-1 predicts approximately cubed-shaped tanks. Therefore, Equation AT-1 is used for tanks greater than 10 m^3.

The largest tank in the LO aeration category is 25,000 m^3, and the projected depth for this tank is 6.6 m (22 ft), which is acceptable for mixing tanks. The largest tank in the HI aeration category is 114,000 m^3, and the projected depth for this tank is 8.1 m (27 ft). In evaluating the depths of mechanically aerated tanks, however, the maximum depth was 6.1 m (20 ft). Even this depth appeared to be an outlier compared to the other HI aeration, mechanically aerated tanks. Data were available for eight tanks (two of which were the TSDF model tanks). The other seven tanks all had depths ranging from 3.35 m (11 ft) to 4.88 m (16 ft). The mid-range of the latter depths is approximately equivalent to a 1,000-m^3 tank as calculated using Equation AT-1. Therefore, for HI aeration tanks greater than 1,000 m^3, a random (maximum) depth is set from the expected range of depths for HI aeration units.

3.8.2.4 Estimating Tank Depth (d_wmu) from Tank Capacity. In the following calculation algorithms the nomenclature random#(X to Y) indicates that a random number was selected based on a normal distribution, with 90 percent of the values falling within the range of X to Y.

Estimating depth for LO aeration tanks, nonaerated tanks, and storage tanks:

- If tank capacity is <10 m^3, depth = random#(0.8 to 1.2)*capacity$^{0.333}$.
- If tank capacity is >=10 m^3, use Equation AT-1 and then apply a random variation on the calculated depth [i.e., random#(0.8 to 1.2)].

Estimating depth for HI aeration tanks:

- If tank capacity is <10 m^3, depth = random#(0.8 to 1.2)*capacity$^{0.333}$.
- If 10 m^3 <= tank capacity <=1,000 m^3, use Equation AT-1 and then apply a random variation [i.e., random#(0.8 to 1.2)].
- Above 1,000 m^3, use random#(3.5 to 4.8) and then apply a random variation on the calculated depth [i.e., random#(0.8 to 1.2)].

3.8.2.5 Surface Area (SrcArea). Tank surface area values were calculated, based on the database value for tank volume and the projected values for tank depth.

3.8.2.6 Source Height (SHight). Because the heights of the tanks in the TSDR database were not provided, source height for tanks (SHight) was randomly generated for each tank in the 624-tank data set. Based on professional experience, it was assumed that tank heights do not exceed 20 m, that some tanks (especially larger ones) are buried beneath the ground surface, and that there can be some freeboard height (0.5 m aboveground) for every tank.

Given this perspective, SHight was randomly selected once for each of the 624 tanks in the data set from a uniform distribution ranging from 0 to 20 m. If the randomly selected value was less than the tank depth (d_wmu) + 0.5 m, the value was placed in the data set. Otherwise, SHight was set to d_wmu + 0.5 m.

3.8.2.7 Fraction Surface Area Turbulent (F_aer). Three aeration levels were assumed to exist: (1) HI aeration when agitation is used for biological treatment or other high-energy processes, (2) LO aeration for mixing processes, and (3) NO aeration for complete quiescence.

Aeration categories (HI/LO/NO) were assigned according to the waste treatment classification, as shown in Appendix 3B, Table 3B-3. The following aeration distributions were developed based on best engineering judgment:

- The HI aeration was assumed to follow a normal distribution, centered on a fraction turbulent area of 0.75, with a standard deviation of 0.1 and no values above 1.0.

- The LO aeration was assumed to follow a normal distribution, centered on a fraction turbulent of 0.50, with a standard deviation of 0.2 and no values above 0.8 or below 0.2.

3.8.2.8 Total Aerator Horsepower (Powr). Total aerator horsepower was calculated based on the following algorithm:

- The HI aeration power was assumed to follow a normal distribution, with 90 percent of the values falling between 80 and 150 hp per million gals of tank volume (Tchobanoglous, 1979).

- The LO aeration power was assumed to follow a normal distribution, with 90 percent of the values between 15 and 45 hp per million gals of tank volume. This estimate was based on references that indicate surface aerators used for mixing typically have power levels of 15 to 20 hp/million gal (Adams and Eckenfelder, 1974) and that minimum surface aerator power to mix activated sludge tanks is 20 to 30 hp/million gal (WPCF, 1988). The upper value of 30 hp was multiplied by 1.5, with a resultant value of 45 hp/million gal, to provide values above the minimum.

- Set the minimum Total Aerator Power to 0.25 hp, if the estimated value is less than 0.25 hp based on the minimum size of commercially available mixers for containers holding 55 gal or more.

3.8.2.9 Number of Impellers/Aerators (n_imp). The number of impellers/aerators (n_imp) is determined based on the total aerator horsepower as follows:

- For Total Power $\leq$25 hp, n_imp = 1.

- For 25 hp < Total Power <80 hp, randomly pick 1 or 2 (equal probability).

- For Total Power $\geq$80 hp, randomly pick a number between 60 and 100 (uniform distribution) and then divide the Total Power by the random number and round up to the next integer.

3.8.3 Aerated Tank National Data

Noncorrelated tank variables included in the national data tables for the HWIR modeling system are described below.

3.8.3.1 Biologically Active Solids/Total Solids Ratio (kba1). Values for the ratio of biologically active solids to total solids were assumed to be uniformly distributed between 0.7 and 0.9. The range is based on data from Tchobanoglous (1979).

3.8.3.2 Biomass Yield (bio_yield). Values for biomass yield are assumed to vary uniformly from 0.4 to 0.8 g/g. This is based on a range of 0.4 to 0.8 mg VSS/mg BOD_5 reported by Tchobanoglous (1979).

3.8.3.3 Digestion (k_dec). Values for digestion of sediments are assumed to vary uniformly from 4.6×10^{-7} to 8.7×10^{-7}, based on data from Tchobanoglous (1979).

3.8.3.4 Economic Life of AT (EconLife). The economic life of an aerated tank is assumed to be 20 yr.

3.8.3.5 Fraction of Tank Occupied by Sediments (d_setpt). The maximum fraction of the tank occupied by sediments is set equal to 0.3.

3.8.3.6 Impeller Diameter (d_imp). The impeller diameter was assumed to have a fixed value of 61 cm, based on U.S. EPA (1990).

3.8.3.7 Impeller Speed (w_imp). The value for impeller speed was assumed to be fixed at 126 rad/s. This is based on data from U.S. EPA (1990).

3.8.3.8 Number of Economic Lifetimes (NumEcon). The number of economic lifetimes for an aerated tank is fixed at 2.5. Combined with an EconLife value of 20 yr, this places a tank at each facility with a surface impoundment for the assumed lifetime of the surface impoundment (50 yr).

3.8.3.9 Oxygen Transfer Correction Factor (O2eff). The value for the oxygen transfer factor was fixed at 0.83, based on data from Tchobanoglous (1979).

3.8.3.10 Oxygen Transfer Factor (J). Values for the oxygen transfer factor were assumed to be fixed at 3.0 lb O_2/hp h. This is the median of the recommended range of 2.0 and 4.0 lb O_2/hp h based on data from Tchobanoglous (1979).

3.9 Quality Assurance/Quality Control

For the Industrial D data collection effort, manual calculations or data entry were checked 100 percent against their original references. Automated data extraction (or data processing) was checked for accuracy by checking approximately 10 percent of the values. Checks were conducted across WMU types to ensure that calculations in the database were correct.

Quality Assurance/quality control (QA/QC) of national data collection was based on a combination of internal and external review checks and collection of data from multiple sources for each parameter of interest. As described in Section 3.2.3, data for design parameters were generally sought from multiple sources. This helped to ensure that the data collected were representative of standard industry practice. When no standard industry practice existed and parameter values were found to be highly variable, using multiple data sources aided the characterization of parameter variability, which then became a consideration in the model unit designs.

Quality of the data sources was reviewed, and all data elements were entered into a database along with an indicator of the data source and the general estimated quality. Data quality was ranked as follows:

- In general, more recent literature sources were considered of higher quality than older sources.

- Standard reference texts were generally considered of higher quality than information collected by telephone or from the Internet.

- Engineering calculations were considered of lower quality than data from the literature.

- Engineering judgment was considered the lowest quality source.

Internal reviews consisted of senior engineering reviews of individual parameter values for realism and reviews of overall model system designs to ensure that parameter estimates within the model were internally consistent. For example, for an aerated tank, impeller parameter estimates, aerator requirements, flow rates, and biomass yield data should be consistent for a given facility design. External reviews of model facility designs and parameter estimates were also conducted to ensure that these were representative of typical industry practices.

Quality assurance was conducted to ensure that an adequate QC methodology was in place and correctly implemented and recorded. QA/QC records for WMU data processing can be provided on request.

3.10 Issues and Uncertainties

3.10.1 Age/Accuracy of Industrial D Data

For the nationally collected data, one issue of concern was the availability of recent data on actual Industrial D units (the Industrial D data is more than 10 years old). Although significant data can be found on Subtitle C waste management units (e.g., permit records, design requirements), recent Industrial D data are not compiled or readily available. In spite of its age, the Industrial D Screening Survey represents the largest consistent set of data available on facility locations and WMU dimensions. The 201-facility sample was selected from the survey to represent the types and geographical locations of WMUs at which nonhazardous wastes might be disposed. At some of the 201 facilities, there probably have been WMU additions or closures since the survey was conducted. We consider this approach of basing the assessment on actual WMU, land use, and population data, however, to be preferable to developing and evaluating hypothetical exposure scenarios.

Another issue that was identified during use of the Industrial D data were whether to revisit the methodology used to screen out questionable entries in the Industrial D database. For consistency, it was decided to use the methodology from previous EPACMTP modeling efforts, as described in U.S. EPA (1997).

3.10.2 Underrepresentation of Highly Aerated Tanks

The tank database appears to underrepresent highly aerated tanks. This is probably due to a disproportionate number of aerated biological treatment systems being operated at facilities that only process on-site waste. This under representation introduces some uncertainty into the analysis, the result of which is that risks from highly aerated tanks may be underestimated.

3.11 References

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Appendix 3A

WMU Data

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Table 3A-1. WMU Data from the Industrial D Screening Survey

Landfill Industrial D Data								Landfill Calculated FRAMES Inputs								
IDNum	Total LF	Depth (m) SrcDepth	Average surface area (acres)	Average surface area (m2) SrcArea	Average capacity (Mg)	Capacity replaced?	Average waste quantity (Mg)	Vehicles per day (1/d) nv	Vehicle weight (Mg) vw	Wheels per vehicle nw	Distance vehicle travels on LF (m) mt	Frequency of surface disturbance per month (1/mo) fd	Spreading/ compacting operations per day (1/d) Nop	Waste loading rate (dry, Mg/yr) load	Waste zone thickness (m) zW	No. waste layers in a cell Nly
0114001																
0130207																
0131104																
0131207																
0131508	1	4.67594	110	445170	3746855	0	140507	8.25952	50.7	10	667.211	60	2	124895	4.675935	5
0136703																
0220102																
0221207																
0223504	1	2.69	0.5	2023.5	9797.8	0	136.1	0.04968	24	6	44.9833	1.490273	0.0496758	326.59	2.690004	3
0224002																
0231002	1	0.50947	3.3	13355.1	12247.2	0	1020.6	0.06209	24	6	115.564	1.8628337	0.0620945	408.24	0.509468	1
0231106	1	0.53136	15	60705	58060.8	0	3011.9	0.29437	24	6	246.384	8.8312115	0.2943737	1935.4	0.531357	1
0231407	1	1.17521	7.1	28733.7	60782.4	0	14515.2	0.30817	24	6	169.51	9.2451745	0.3081725	2026.1	1.175205	2
0231610																
0231911																
0231914																
0232305																
0232313	3	2.49073	33.3333	134900	604800	0	5911.8	3.06639	24	6	367.287	60	2	20160	2.490734	2
0232402	1	6.61257	11.3	45731.1	544320	0	16547.3	2.75975	24	6	213.848	60	2	18144	6.612568	7
0232415																
0232501	1	7.37858	0.8	3237.6	43000	0	0.005	0.21801	24	6	56.8999	6.5404213	0.218014	1433.3	7.378579	7
0232705																
0233601																
0233603	1	1.07627	2	8094	15680.4	-1	13608	0.0795	24	6	89.9667	2.3850403	0.0795013	522.68	1.076274	2
0234904	1	1.86805	4	16188	54432	0	9072	0.27598	24	6	127.232	8.2792608	0.2759754	1814.4	1.86805	2
0235301	1	6.34689	100	404700	4623455	-1	1262.8	10.1919	50.7	10	636.16	60	2	154115	6.34689	6
0312301																
0314202	1	0.7279	0.2	809.4	1060.49	-1	1.5	0.00538	24	6	28.45	0.1613028	0.0053768	35.35	0.727895	1
0321802																
0331006																
0331902																
0332104																
0332707	1	0.74257	5	20235	27046.7	-1	13.6	0.13713	24	6	142.25	4.1138835	0.1371295	901.56	0.742573	1
0332811																
0430108																
0430412	1	1.44921	5	20235	52784.5	-1	72.6	0.26762	24	6	142.25	8.0286638	0.2676221	1759.5	1.449207	2
0431912	1	7.82897	137	554439	7813232	-1	9353232	17.2234	50.7	10	744.607	60	2	260441	7.828967	8
0432011	1	0.64761	2	8094	9435.19	-1	108.9	0.04784	24	6	89.9667	1.4351187	0.0478373	314.51	0.647612	1
0432106																
0432716																
0433201	1	6.19311	3.61	14609.7	162863	-1	175634	0.82573	24	6	120.87	24.771895	0.8257298	5428.8	6.193114	6
0433204																
0433404	2	3.1088	13.5	54634.5	305726	0	161028	1.55006	24	6	233.74	46.501848	1.5500616	10191	3.108805	3
0433408																
0434505																
0434804																
0435510																
0436007																
0436108																

(continued)

Table 3A-1. (continued)

	Landfill Industrial D Data							Landfill Calculated FRAMES Inputs								
IDNum	Total LF	Depth (m) SrcDepth	Average surface area (acres)	Average surface area (m2) SrcArea	Average capacity (Mg)	Capacity replaced?	Average waste quantity (Mg)	Vehicles per day (1/d) nv	Vehicle weight (Mg) vw	Wheels per vehicle nw	Distance vehicle travels on LF (m) mt	Frequency of surface disturbance per month (1/mo) fd	Spreading/ compacting operations per day (1/d) Nop	Waste loading rate (dry, Mg/yr) load	Waste zone thickness (m) zW	No. waste layers in a cell Nly
0530901																
0531301																
0531502																
0531702	2	0.84911	22	89034	136080	0	798.35	0.68994	24	6	298.386	20.698152	0.6899384	4536	0.849114	1
0531902																
0534504																
0613402																
0620401																
0620604																
0621603																
0621902																
0622902																
0625002	1	2.17057	0.34	1375.98	5376	0	299.4	0.02726	24	6	37.0942	0.8177048	0.0272568	179.2	2.170574	2
0625501																
0631701																
0631903	1	0.79703	20	80940	116122	0	36.3	0.58875	24	6	284.5	17.662423	0.5887474	3870.7	0.797035	1
0632003	1	0.69594	3.4	13759.8	17236.8	0	5806.1	0.08739	24	6	117.302	2.6217659	0.0873922	574.56	0.69594	1
0632606	3	4.37714	22.9567	92905.6	731989	-1	5140.8	3.71125	24	6	304.804	60	2	24400	4.377137	4
0632608	1	0.6427	9.99	40429.5	46771.2	0	10.9	0.23713	24	6	201.071	7.1140315	0.2371344	1559	0.642699	1
0634001																
0635301																
0713618																
0713705	2	4.40545	5	20235	160460	-1	2903.05	0.81355	24	6	142.25	24.406377	0.8135459	5348.7	4.40545	4
0715007																
0715216																
0716701																
0720506																
0720803	1	6.52385	3	12141	142571	-1	22.7	0.72285	24	6	110.186	21.685441	0.722848	4752.4	6.523851	7
0721305																
0722107																
0722503																
0722505																
0722705	1	1.58142	0.07	283.29	806.4	0	121	0.00409	24	6	16.8312	0.1226557	0.0040885	26.88	1.581418	2
0723607																
0724206																
0724301																
0724804																
0724909																
0730407	1	1.88509	2.87	11614.9	39411.1	-1	272.2	0.19982	24	6	107.772	5.9945467	0.1998182	1313.7	1.885087	2
0730502																
0730914	1	1.99259	2	8094	29030.4	0	206.8	0.14719	24	6	89.9667	4.4156057	0.1471869	967.68	1.992587	2
0731111																
0731405																
0731411																
0731412																
0731501																
0731507																
0731514	1	2.29914	65	263055	1088640	0	14515.2	2.39979	50.7	10	512.889	60	2	36288	2.299139	2
0731703	1	1.83142	0.34	1375.98	4536	0	90.7	0.023	24	6	37.0942	0.6899384	0.0229979	151.2	1.831422	2
0732110	1	4.30496	4.5	18211.5	141120	0	3774	0.71549	24	6	134.95	21.464705	0.7154902	4704	4.304963	4
0732405																
0732510																

(continued)

Table 3A-1. (continued)

Landfill Industrial D Data								Landfill Calculated FRAMES Inputs								
		Depth (m)	Average surface area (acres)	Average surface area (m2)	Average capacity (Mg)	Capacity replaced?	Average waste quantity (Mg)	Vehicles per day (1/d)	Vehicle weight (Mg)	Wheels per vehicle	Distance vehicle travels on LF (m)	Frequency of surface disturbance per month (1/mo)	Spreading/ compacting operations per day (1/d)	Waste loading rate (dry, Mg/yr)	Waste zone thickness (m)	No. waste layers in a cell
IDNum	Total LF	SrcDepth		SrcArea				nv	vw	nw	mt	fd	Nop	load	zW	Nly
0733203																
0733210	1	0.61858	3	12141	13518.3	-1	7257.6	0.06854	24	6	110.186	2.0561646	0.0685388	450.61	0.618577	1
0733302																
0733404	1	0.71266	5.7	23067.9	29591.3	-1	0.005	0.15003	24	6	151.881	4.5009254	0.1500308	986.38	0.712663	1
0733501																
0733606																
0734604																
0735309	3	1.38734	6.66667	26980	67374.7	0	1372.9	0.3416	24	6	164.256	10.247887	0.3415962	2245.8	1.387339	2
0826707																
0830601	2	1.75846	10	40470	128097	0	13608	0.64946	24	6	201.172	19.483862	0.6494621	4269.9	1.758458	2
0830903	1	0.50922	45	182115	166925	0	5080.3	0.84632	24	6	426.749	25.389733	0.8463244	5564.2	0.509217	1
0831102																
0831406	2	0.80395	36	145692	210833	0	25054.2	1.06894	24	6	381.696	32.06834	1.0689447	7027.8	0.803954	1
0831904	1	3.7361	40	161880	1088640	0	54432	2.39979	50.7	10	402.343	60	2	36288	3.736101	4
0832304	1	1.59118	293	1185771	3396194	0	504908	7.48653	50.7	10	1088.93	60	2	113206	1.591179	2
0832510																
0832903																
0832904																
0832909																
0833001	2	1.66049	180	728460	2177280	0	108864	4.79957	50.7	10	853.499	60	2	72576	1.660489	2
0833007	1	2.79912	50	202350	1019525	-1	3810.2	2.24743	50.7	10	449.833	60	2	33984	2.799125	3
0834009																
0923004																
0930205																
0930301	1	1.5656	2.8	11331.6	31933.4	0	544.3	0.16191	24	6	106.45	4.8571602	0.1619053	1064.4	1.565602	2
0930702	4	0.67636	23.875	96622.1	117632	-1	6804	0.59641	24	6	310.841	17.892161	0.5964054	3921.1	0.676358	1
0932103	1	1.11851	4	16188	32591.5	-1	181.4	0.16524	24	6	127.232	4.9572546	0.1652418	1086.4	1.118506	2
0932507																
0932509	2	7.16666	20.405	82579	1065269	-1	96163.2	2.34827	50.7	10	287.366	60	2	35509	7.166663	7
0932903	1	0.55195	75	303525	301553	0	12236	1.5289	24	6	550.931	45.867108	1.5289036	10052	0.551947	1
0933704																
1010805																
1012203	1	3.26705	0.5	2023.5	11899.6	-1	27.2	0.06033	24	6	44.9833	1.8099585	0.0603319	396.65	3.267049	3
1013209																
1014805	1	7.5742	30	121410	1655250	-1	18.1	3.64882	50.7	10	348.439	60	2	55175	7.574199	8
1015510	1	1.18822	0.03	121.41	259.67	-1	9.1	0.00132	24	6	11.0186	0.0394966	0.0013166	8.6557	1.188216	2
1023705																
1031503																
1031507																
1032715																
1032802	1	3.34048	16	64752	389345	-1	3774	1.97401	24	6	254.464	59.2204	1.9740133	12978	3.340476	3
1033107																
1033114																
1033202																
1033602																
1034005																
1034210																
1034406																
1034805																
1035117																
1035405																
1035508																

(continued)

Table 3A-1. (continued)

Landfill Industrial D Data									Landfill Calculated FRAMES Inputs							
		Depth (m)	Average surface area (acres)	Average surface area (m2)	Average capacity (Mg)	Capacity replaced?	Average waste quantity (Mg)	Vehicles per day (1/d)	Vehicle weight (Mg)	Wheels per vehicle	Distance vehicle travels on LF (m)	Frequency of surface disturbance per month (1/mo)	Spreading/ compacting operations per day (1/d)	Waste loading rate (dry, Mg/yr)	Waste zone thickness (m)	No. waste layers in a cell
IDNum	Total LF	SrcDepth		SrcArea				nv	vw	nw	mt	fd	Nop	load	zW	Nly
1120904																
1122705																
1131103																
1131802																
1133902																
1134405																
1212301																
1221704																
1223404																
1230111																
1230206																
1230517																
1230919																
1231101																
1231705																
1233101																
1235205																
1236637																
1236652																
1236732																
1236810																
1236820																
1331103																
1333001																
1333701																
1415407																
1421506																
1430107	2	2.17581	33.65	136182	533350	-1	2721.6	2.70413	24	6	369.028	60	2	17778	2.175811	2
1430404																
1430602																
1431515																
1434022																
1434802																
1435317	1	1.22999	7.5	30352.5	67199.9	0	1633	0.34071	24	6	174.22	10.221294	0.3407098	2240	1.22999	2
1522504																
1530605	1	5.09655	13	52611	482642	-1	2721.6	2.44704	24	6	229.371	60	2	16088	5.096549	5
1530808																
1532401																
1621808																
1630106	1	0.75281	4.5	18211.5	24677.7	0	4644.9	0.12512	24	6	134.95	3.7535478	0.1251183	822.59	0.752812	1
1630401																
1631701																
1632106																
1632703	1	3.18078	2	8094	46341.4	-1	4.5	0.23496	24	6	89.9667	7.0486603	0.2349553	1544.7	3.18078	3
1633404																
1633405																
1635404																
1721603																

(continued)

Table 3A-1. (continued)

Waste Pile Industrial D Data						Waste Pile Calculated FRAMES Inputs						
IDNum	Total WP	Average surface area (acres)	Average surface area (m2)	Average waste quantity (Mg)	Waste quantity replaced?	Height of waste pile above grade (m)	Distance vehicle travels on WP (m)	Vehicles per day (1/d)	Vehicle weight (Mg)	Wheels per vehicle	Spreading/ compacting operations per day	Waste loading rate (dry, Mg/yr)
			SrcArea			zZ1WMU	mt	nv	vw	nw	Nop	load
0114001	2	0.025	101.175	2968.068	yes	4	10.0586	0.45145	33	6	0.4514515	2968.07
0130207	1	0.11	445.17	11249.3		4	21.0991	1.71105	33	6	1.7110503	11249.3
0131104												
0131207												
0131508	1	0.08	323.76	4536		2	17.9933	0.68994	33	6	0.6899384	4536
0136703												
0220102	1	1.2	4856.4	2449.4		1	69.6879	0.37256	33	6	0.3725607	2449.4
0221207	1	0.005	20.235	453.6		4	4.49833	0.06899	33	6	0.0689938	453.6
0223504	1	6.5	26305.5	153240.2	yes	1	162.19	10.134	71.4	10	2	153240
0224002	1	0.04	161.88	128.4		1	12.7232	0.01953	33	6	0.01953	128.4
0231002												
0231106												
0231407												
0231610												
0231911	3	5.33333	21584	60480		1	146.915	3.99964	71.4	10	2	60480
0231914												
0232305	1	0.52	2104.44	2720.692	yes	1	45.8742	0.41382	33	6	0.4138249	2720.69
0232313	1	1.55	6272.85	34083.02	yes	1	79.2013	2.25397	71.4	10	2	34083
0232402												
0232415	1	0.06	242.82	81648		10	15.5827	5.39952	71.4	10	2	81648
0232501	1	0.16	647.52	1576.505	yes	1	25.4464	0.23979	33	6	0.2397909	1576.51
0232705												
0233601												
0233603												
0234904												
0235301												
0312301												
0314202												
0321802	1	1.38	5584.86	30437.59	yes	1	74.7319	2.01289	71.4	10	2	30437.6
0331006												
0331902	1	0.45	1821.15	2269.775	yes	1	42.6749	0.34524	33	6	0.3452392	2269.78
0332104	3	0.23	930.81	316.1739	yes	1	30.5092	0.04809	33	6	0.0480909	316.174
0332707	2	75	303525	158760		1	550.931	10.4991	71.4	10	2	158760
0332811	1	0.005	20.235	107		1	4.49833	0.01628	33	6	0.016275	107
0430108	1	0.21	849.87	659.6076	yes	1	29.1525	0.10033	33	6	0.1003282	659.608
0430412												
0431912												
0432011												
0432106												
0432716												
0433201												
0433204												
0433404												
0433408												
0434505												
0434804												
0435510												
0436007												
0436108												
0530901												
0531301												
0531502												
0531702												
0531902												
0534504												
0613402												
0620401												
0620604												
0621603												
0621902												
0622902												
0625002												

(continued)

Table 3A-1. (continued)

Waste Pile Industrial D Data						Waste Pile Calculated FRAMES Inputs						
IDNum	Total WP	Average surface area (acres)	Average surface area (m2)	Average waste quantity (Mg)	Waste quantity replaced?	Height of waste pile above grade (m)	Distance vehicle travels on WP (m)	Vehicles per day (1/d)	Vehicle weight (Mg)	Wheels per vehicle	Spreading/ compacting operations per day	Waste loading rate (dry, Mg/yr)
			SrcArea			zZ1WMU	mt	nv	vw	nw	Nop	load
0625501												
0631701												
0631903												
0632003												
0632606												
0632608												
0634001												
0635301												
0713618												
0713705												
0715007	1	0.5	2023.5	1590.265	yes	1	44.9833	0.24188	33	6	0.2418837	1590.26
0715216	1	0.005	20.235	562.8561	yes	4	4.49833	0.08561	33	6	0.085612	562.856
0716701												
0720506	1	0.1	404.7	1546.653	yes	1	20.1172	0.23525	33	6	0.2352503	1546.65
0720803												
0721305	1	0.17	687.99	4536		1	26.2296	0.68994	33	6	0.6899384	4536
0722107	1	0.06	242.82	3692.677	yes	2	15.5827	0.56167	33	6	0.5616666	3692.68
0722503												
0722505												
0722705												
0723607												
0724206	1	2	8094	2721.6		1	89.9667	0.41396	33	6	0.413963	2721.6
0724301	1	0.01	40.47	1088.6		4	6.3616	0.16558	33	6	0.1655791	1088.6
0724804	1	0.005	20.235	30.22716	yes	1	4.49833	0.0046	33	6	0.0045976	30.2272
0724909	1	0.02	80.94	571.8954	yes	1	8.99667	0.08699	33	6	0.0869869	571.895
0730407												
0730502	2	0.61	2468.67	33763.27	yes	2	49.6857	2.23282	71.4	10	2	33763.3
0730914	6	0.01333	53.96	756		2	7.34575	0.11499	33	6	0.1149897	756
0731111												
0731405												
0731411	1	0.01	40.47	499		2	6.3616	0.0759	33	6	0.0758993	499
0731412	1	3	12141	13644.38	yes	1	110.186	2.07535	33	6	2	13644.4
0731501												
0731507	20	0.12	485.64	1723.68		1	22.0372	0.26218	33	6	0.2621766	1723.68
0731514												
0731703												
0732110												
0732405	1	0.01	40.47	1134		4	6.3616	0.17248	33	6	0.1724846	1134
0732510	1	0.37	1497.39	2721.6		1	38.6961	0.41396	33	6	0.413963	2721.6
0733203												
0733210												
0733302	1	0.09	364.23	124.1385	yes	1	19.0848	0.01888	33	6	0.0188818	124.138
0733404	1	0.09	364.23	136.1151	yes	1	19.0848	0.0207	33	6	0.0207035	136.115
0733501												
0733606	1	50	202350	174800	yes	1	449.833	11.5598	71.4	10	2	174800
0734604	2	0.0025	10.1175	18.15		1	3.1808	0.00276	33	6	0.0027607	18.15
0735309												
0826707												
0830601												
0830903												
0831102	1	4	16188	27659.75	yes	1	127.232	4.20713	33	6	2	27659.7
0831406												
0831904												
0832304	1	0.12	485.64	81179.9		10	22.0372	5.36856	71.4	10	2	81179.9
0832510	1	0.01	40.47	1360.8		4	6.3616	0.20698	33	6	0.2069815	1360.8
0832903	3	16.6667	67450	492625.3	yes	1	259.711	32.5781	71.4	10	2	492625
0832904												
0832909												
0833001												
0833007												
0834009												

(continued)

Table 3A-1. (continued)

Waste Pile Industrial D Data						Waste Pile Calculated FRAMES Inputs						
IDNum	Total WP	Average surface area (acres)	Average surface area (m2)	Average waste quantity (Mg)	Waste quantity replaced?	Height of waste pile above grade (m)	Distance vehicle travels on WP (m)	Vehicles per day (1/d)	Vehicle weight (Mg)	Wheels per vehicle	Spreading/ compacting operations per day	Waste loading rate (dry, Mg/yr)
			SrcArea			zZ1WMU	mt	nv	vw	nw	Nop	load
0923004	1	0.005	20.235	77.69577	yes	1	4.49833	0.01182	33	6	0.0118177	77.6958
0930205	1	0.2	809.4	429.3907	yes	1	28.45	0.06531	33	6	0.0653115	429.391
0930301	1	0.25	1011.75	3175.2		1	31.808	0.48296	33	6	0.4829569	3175.2
0930702												
0932103	1	2.07	8377.29	14453.58	yes	1	91.5275	2.19843	33	6	2	14453.6
0932507	1	0.25	1011.75	396.287	yes	1	31.808	0.06028	33	6	0.0602764	396.287
0932509	1	0.57	2306.79	9072		1	48.0291	1.37988	33	6	1.3798768	9072
0932903												
0933704												
1010805												
1012203	1	0.5	2023.5	4481.975	yes	1	44.9833	0.68172	33	6	0.681721	4481.97
1013209												
1014805												
1015510												
1023705												
1031503												
1031507												
1032715												
1032802												
1033107												
1033114												
1033202												
1033602												
1034005	1	0.4	1618.8	1763.243	yes	1	40.2343	0.26819	33	6	0.2681943	1763.24
1034210												
1034406												
1034805												
1035117												
1035405												
1035508												
1120904												
1122705												
1131103												
1131802												
1133902												
1134405												
1212301												
1221704	1	0.18	728.46	3216.37	yes	1	26.99	0.48922	33	6	0.489219	3216.37
1223404												
1230111												
1230206												
1230517												
1230919	1	0.04	161.88	2348.422	yes	2	12.7232	0.3572	33	6	0.3572017	2348.42
1231101												
1231705												
1233101												
1235205	1	0.23	930.81	907.2		1	30.5092	0.13799	33	6	0.1379877	907.2
1236637												
1236652												
1236732	1	0.005	20.235	49.9		1	4.49833	0.00759	33	6	0.0075899	49.9
1236810	3	0.00167	6.745	7.566667		1	2.59711	0.00115	33	6	0.0011509	7.56667
1236820												
1331103												
1333001												
1333701	4	0.0125	50.5875	54.82949	yes	1	7.11249	0.00834	33	6	0.0083397	54.8295
1415407	1	0.005	20.235	1048.087	yes	6	4.49833	0.15942	33	6	0.159417	1048.09
1421506	2	0.115	465.405	276.7		1	21.5732	0.04209	33	6	0.0420869	276.7
1430107												
1430404												
1430602												
1431515												
1434022												

(continued)

Table 3A-1. (continued)

Waste Pile Industrial D Data						Waste Pile Calculated FRAMES Inputs						
IDNum	Total WP	Average surface area (acres)	Average surface area (m2)	Average waste quantity (Mg)	Waste quantity replaced?	Height of waste pile above grade (m)	Distance vehicle travels on WP (m)	Vehicles per day (1/d)	Vehicle weight (Mg)	Wheels per vehicle	Spreading/ compacting operations per day	Waste loading rate (dry, Mg/yr)
			SrcArea			zZ1WMU	mt	nv	vw	nw	Nop	load
1434802												
1435317												
1522504												
1530605												
1530808												
1532401	2	0.0025	10.1175	119.3817	yes	2	3.1808	0.01816	33	6	0.0181583	119.382
1621808												
1630106	1	0.02	80.94	51		1	8.99667	0.00776	33	6	0.0077572	51
1630401	1	0.07	283.29	2038.266	yes	1	16.8312	0.31003	33	6	0.3100261	2038.27
1631701												
1632106												
1632703												
1633404												
1633405												
1635404												
1721603												

(continued)

Table 3A-1. (continued)

Land Application Unit Industrial D Data						Land Application Unit Calculated FRAMES Inputs							
IDNum	Total LAU	Average surface area (acres)	Average surface area (m2)	Average waste quantity (Mg)	Waste quantity replaced?	Wet waste application rate (Mg/m2-yr)	Vehicles per day (1/d)	Vehicle weight (Mg)	Wheels per vehicle	Waste applications per Year (1/yr)	Distance vehicle travels on LAU (m)	Frequency of surface disturbance per month (1/mo)	Number of cultivations per application
			SrcArea			Rappl	nv	vw	nw	Nappl	mt	fd	fcult
0114001													
0130207													
0131104													
0131207													
0131508													
0136703	2	67.5	273172.5	13208.7		0.0483528	3.01361	21	6	88.057667	522.6591	14.676278	2
0220102													
0221207													
0223504	2	5	20235	217.75		0.0107611	0.04968	21	6	14.516667	142.2498	2.4194444	2
0224002													
0231002													
0231106													
0231407													
0231610													
0231911													
0231914													
0232305													
0232313													
0232402													
0232415													
0232501													
0232705													
0233601													
0233603													
0234904													
0235301													
0312301	2	10	40470	37.75		0.0009328	0.00861	21	6	2.5166667	201.1716	0.2097222	1
0314202													
0321802													
0331006													
0331902													
0332104	1	100	404700	509477		1.2588992	50.5388	43.8	10	33.9651	636.1604	11.3217	4
0332707													
0332811													
0430108													
0430412													
0431912													
0432011													
0432106													
0432716													
0433201													
0433204													
0433404													
0433408													
0434505													
0434804													
0435510	1	6.5	26305.5	1.4		5.322E-05	0.00032	21	6	1	162.1897	0.0833333	1
0436007													
0436108													
0530901	1	5	20235	4126		0.2039041	0.94136	21	6	27.506667	142.2498	6.8766667	3
0531301													
0531502													
0531702													
0531902													
0534504													
0613402													
0620401													
0620604													
0621603													
0621902													
0622902													
0625002													

(continued)

Table 3A-1. (continued)

Land Application Unit Industrial D Data						Land Application Unit Calculated FRAMES Inputs							
IDNum	Total LAU	Average surface area (acres)	Average surface area (m2)	Average waste quantity (Mg)	Waste quantity replaced?	Wet waste application rate (Mg/m2-yr)	Vehicles per day (1/d)	Vehicle weight (Mg)	Wheels per vehicle	Waste applications per Year (1/yr)	Distance vehicle travels on LAU (m)	Frequency of surface disturbance per month (1/mo)	Number of cultivations per application
			SrcArea			Rappl	nv	vw	nw	Nappl	mt	fd	fcult
0625501	1	33	133551	7547.8		0.0565162	1.72206	21	6	50.318667	365.4463	8.3864444	2
0631701	1	1	4047	39.6		0.009785	0.00903	21	6	2.64	63.61604	0.22	1
0631903													
0632003													
0632606													
0632608													
0634001													
0635301													
0713618													
0713705													
0715007													
0715216													
0716701													
0720506													
0720803	3	1.33333	5396	3.03333		0.0005621	0.00069	21	6	1	73.45747	0.0833333	1
0721305													
0722107													
0722503													
0722505													
0722705													
0723607													
0724206													
0724301													
0724804													
0724909													
0730407													
0730502													
0730914													
0731111													
0731405													
0731411													
0731412													
0731501													
0731507													
0731514													
0731703													
0732110													
0732405													
0732510													
0733203													
0733210													
0733302													
0733404													
0733501													
0733606													
0734604													
0735309													
0826707													
0830601													
0830903													
0831102													
0831406													
0831904	1	300	1214100	754780		0.6216786	74.8723	43.8	10	50.318667	1101.862	12.579667	3
0832304													
0832510													
0832903													
0832904													
0832909													
0833001													
0833007													
0834009													
0923004													

(continued)

Table 3A-1. (continued)

Land Application Unit Industrial D Data						Land Application Unit Calculated FRAMES Inputs							
IDNum	Total LAU	Average surface area (acres)	Average surface area (m2)	Average waste quantity (Mg)	Waste quantity replaced?	Wet waste application rate (Mg/m2-yr)	Vehicles per day (1/d)	Vehicle weight (Mg)	Wheels per vehicle	Waste applications per Year (1/yr)	Distance vehicle travels on LAU (m)	Frequency of surface disturbance per month (1/mo)	Number of cultivations per application
			SrcArea			Rappl	nv	vw	nw	Nappl	mt	fd	fcult
0930205													
0930301													
0930702													
0932103													
0932507													
0932509													
0932903													
0933704													
1010805	1	0.5	2023.5	192.5		0.0951322	0.04392	21	6	12.833333	44.98333	2.1388889	2
1012203													
1013209													
1014805													
1015510													
1023705													
1031503	2	31.5	127480.5	1235.95		0.0096952	0.28199	21	6	82.396667	357.0441	6.8663889	1
1031507													
1032715													
1032802	1	60	242820	207565		0.8548081	20.5899	43.8	10	13.837633	492.7677	3.4594083	3
1033107													
1033114													
1033202	3	5	20235	505.6		0.0249864	0.11535	21	6	33.706667	142.2498	5.6177778	2
1033602	1	230	930810	2903		0.0031188	0.66233	21	6	19.353333	964.785	1.6127778	1
1034005	1	13	52611	62269.3		1.1835795	6.17696	43.8	10	41.512867	229.3709	13.837622	4
1034210	1	40	161880	170		0.0010502	0.03879	21	6	11.333333	402.3431	0.9444444	1
1034406													
1034805													
1035117													
1035405													
1035508	1	58.68	237478	108236		0.4557707	10.7367	43.8	10	72.157	487.3171	18.03925	3
1120904													
1122705													
1131103													
1131802	1	5	20235	754.8		0.0373017	0.17221	21	6	50.32	142.2498	8.3866667	2
1133902	1	4	16188	36.6		0.0022609	0.00835	21	6	2.44	127.2321	0.2033333	1
1134405	8	25	101175	61.0125		0.000603	0.01392	21	6	4.0675	318.0802	0.3389583	1
1212301													
1221704													
1223404													
1230111													
1230206													
1230517													
1230919													
1231101	1	5	20235	439.9		0.0217396	0.10037	21	6	29.326667	142.2498	4.8877778	2
1231705	10	14	56658	6415.63		0.1132343	1.46375	21	6	42.770867	238.0294	10.692717	3
1233101													
1235205													
1236637													
1236652													
1236732													
1236810													
1236820													
1331103													
1333001	1	115	465405	17895.8		0.0384521	4.083	21	6	11.930533	682.206	1.9884222	2
1333701													
1415407													
1421506													
1430107													
1430404													
1430602													
1431515													
1434022													
1434802													

(continued)

Table 3A-1. (continued)

	Land Application Unit Industrial D Data					Land Application Unit Calculated FRAMES Inputs							
IDNum	Total LAU	Average surface area (acres)	Average surface area (m2)	Average waste quantity (Mg)	Waste quantity replaced?	Wet waste application rate (Mg/m2-yr)	Vehicles per day (1/d)	Vehicle weight (Mg)	Wheels per vehicle	Waste applications per Year (1/yr)	Distance vehicle travels on LAU (m)	Frequency of surface disturbance per month (1/mo)	Number of cultivations per application
			SrcArea			Rappl	nv	vw	nw	Nappl	mt	fd	fcult
1435317													
1522504	1	0.02	80.94	6.89828	yes	0.0852271	0.00157	21	6	1	8.996666	0.1666667	2
1530605													
1530808													
1532401													
1621808	1	30	121410	86799.7		0.7149304	8.61031	43.8	10	57.866467	348.4394	14.466617	3
1630106													
1630401													
1631701	1	114	461358	5903.9		0.0127968	1.347	21	6	39.359333	679.2334	6.5598889	2
1632106	1	27	109269	31134.7		0.2849363	3.08848	43.8	10	20.756467	330.5586	5.1891167	3
1632703													
1633404													
1633405													
1635404													
1721603													

(continued)

Table 3A-1. (continued)

Surface Impoundment Industrial D Data									Surface Impoundment Calculated FRAMES Inputs					
IDNum	Total SI	Depth (m)	Average surface area (acres)	Average surface area (m2)	Average capacity (Mg)	Capacity replaced?	Average waste quantity (Mg)	Waste quantity replaced?	Fraction of SI occupied by sediments	Depth of SI (m)	Number of impellers/ aerators	Total power to impellers (HP)	Fraction surface area turbulent	Volumetric influent flow rate (m3/s)
		SrcDepth		SrcArea					d_setpt	d_wmu	n_imp	Powr	F_aer	Q_wmu
0114001														
0130207														
0131104	6	4.303853	0.02167	87.685	377.3833	0	138376	0	0.72118	4.3039	1	3.87273	0.23055	0.004385
0131207	3	1.261004	0.22333	903.83	1139.733	0	91831.6	0	0.2	1.261	1	101.11	0.58395	0.00291
0131508	11	11.15607	2.54545	10301.45	114923.8	0	77193.4	0	0.76	11.156	4	441.679	0.22381	0.002446
0136703	1	2.027213	1.38	5584.86	11321.7	0	37739	0	0.408054	2.0272	5	508.532	0.47531	0.001196
0220102														
0221207														
0223504														
0224002														
0231002														
0231106														
0231407														
0231610	1	1.046454	0.02	80.94	84.7	0	1067.3	0	0.2	1.0465	1	10.4212	0.67208	3.38E-05
0231911														
0231914	4	2.494109	0.895	3622.065	9033.825	0	1.3E+07	0	0.518866	2.4941	4	427.011	0.61539	0.411083
0232305														
0232313	1	3.60514	0.13	526.11	1896.7	0	10119.1	0	0.667142	3.6051	1	35.8389	0.35559	0.000321
0232402	8	4.627534	0.665	2691.255	12453.88	0	688737	0	0.740683	4.6275	3	304.909	0.59141	0.021825
0232415	2	2.55745	0.015	60.705	155.25	0	14061.6	0	0.530783	2.5574	1	3.22078	0.27695	0.000446
0232501														
0232705	2	1.219447	6.5	26305.5	32078.15	0	6302413	0	0.2	1.2194	31	2914.93	0.57843	0.199711
0233601	1	1.882876	0.01	40.47	76.2	0	76.2	0	0.362677	1.8829	1	4.68005	0.60365	2.41E-06
0233603														
0234904														
0235301														
0312301	1	0.597762	0.03	121.41	72.57429	-1	75.5	0	0.2	0.5978	1	17.239	0.74119	2.39E-06
0314202														
0321802	4	3.743168	0.25	1011.75	3787.15	0	120204	0	0.679416	3.7432	2	70.1915	0.36214	0.003809
0331006	3	3.252969	1.14667	4640.56	15095.6	0	21385.4	0	0.631106	3.253	4	359.353	0.40422	0.000678
0331902	6	1.154902	1.24667	5045.26	5826.783	0	83654.8	0	0.2	1.1549	6	417.782	0.43225	0.002651
0332104	3	0.951547	1.79667	7271.11	6918.8	0	471738	0	0.2	0.9515	9	775.544	0.55677	0.014948
0332707														
0332811														
0430108	1	2.092732	0.14	566.58	1185.7	0	43203.6	0	0.426587	2.0927	1	38.936	0.35872	0.001369
0430412	2	2.70295	0.345	1396.215	3773.9	0	943.45	0	0.556041	2.703	1	137.468	0.51395	2.99E-05
0431912	1	5.98075	400	1618800	9681638	0	463579	0	0.76	5.9808	54	5000	0.01612	0.01469
0432011														
0432106	4	2.331295	10	40470	94347.5	0	9072000	0	0.485265	2.3313	33	2279.27	0.29399	0.287474
0432716	6	4.557928	100	404700	1844594	0	43545.6	0	0.736723	4.5579	67	5000	0.06449	0.00138
0433201	6	2.682873	58	234726	629740	0	3673.27	0	0.552718	2.6829	65	5000	0.11119	0.000116
0433204	7	6.956878	57.3429	232066.5	1614459	0	88586.4	0	0.76	6.9569	62	5000	0.11247	0.002807
0433404	9	5.469069	18.4556	74689.63	408482.7	0	3944774	0	0.76	5.4691	81	5000	0.34945	0.125002
0433408	6	11.2739	87.5333	354247.4	3993750	0	35252.2	0	0.76	11.274	60	5000	0.07368	0.001117
0434505	1	1.830849	0.9	3642.3	6668.5	0	167	0	0.344566	1.8308	5	545.721	0.78211	5.29E-06
0434804	1	3.562519	145	586815	2090540	0	42094.1	0	0.66316	3.5625	64	5000	0.04448	0.001334
0435510	2	6.684962	25	101175	676351	0	1887327	0	0.76	6.685	67	5000	0.25797	0.059806
0436007	2	0.740663	48	194256	143878.3	0	18098.7	0	0.2	0.7407	53	5000	0.13436	0.000574
0436108	1	7.514657	176	712272	5352480	0	2630880	0	0.76	7.5147	53	5000	0.03664	0.083368
0530901	3	1.877477	0.45	1821.15	3419.167	0	926.1	0	0.360844	1.8775	2	198.396	0.56867	2.93E-05
0531301	12	1.853496	0.63667	2576.59	4775.7	0	1016.43	0	0.352575	1.8535	2	213.685	0.43291	3.22E-05
0531502	2	0.559427	0.025	101.175	56.6	0	33965.1	0	0.2	0.5594	1	5.26862	0.27183	0.001076
0531702														
0531902	7	2.57809	0.02429	98.28429	253.3857	0	37739	0	0.534539	2.5781	1	12.6577	0.67227	0.001196
0534504	1	0.62186	0.06	242.82	151	0	176.589	-1	0.2	0.6219	1	13.2526	0.2849	5.6E-06
0613402	2	9.538046	0.12	485.64	4632.057	-1	37.75	0	0.76	9.538	1	29.9191	0.32159	1.2E-06
0620401	1	0.932518	1	4047	3773.9	0	20379.1	0	0.2	0.9325	4	365.531	0.47148	0.000646
0620604	1	1.16262	300	1214100	1411537	0	49060.7	0	0.2	1.1626	56	5000	0.0215	0.001555
0621603	1	8.048887	0.39	1578.33	12703.8	0	237001	0	0.76	8.0489	1	126.099	0.41705	0.00751
0621902	2	0.420322	0.48	1942.56	816.5	0	299.4	0	0.2	0.4203	1	144.708	0.38886	9.49E-06

(continued)

Table 3A-1. (continued)

Surface Impoundment Industrial D Data									Surface Impoundment Calculated FRAMES Inputs					
IDNum	Total SI	Depth (m)	Average surface area (acres)	Average surface area (m2)	Average capacity (Mg)	Capacity replaced?	Average waste quantity (Mg)	Waste quantity replaced?	Fraction of SI occupied by sediments	Depth of SI (m)	Number of impellers/ aerators	Total power to impellers (HP)	Fraction surface area turbulent	Volumetric influent flow rate (m3/s)
		SrcDepth		SrcArea					d_setpt	d_wmu	n_imp	Powr	F_aer	Q_wmu
0622902	1	1.081173	0.69	2792.43	3019.1	0	754.8	0	0.2	1.0812	5	394.738	0.7379	2.39E-05
0625002	2	5.853484	0.23	930.81	5448.481	-1	145.15	0	0.76	5.8535	1	83.7068	0.46943	4.6E-06
0625501														
0631701														
0631903	7	0.546951	71.4286	289071.4	158108	0	571476	0	0.2	0.547	63	5000	0.09029	0.018109
0632003	5	6.873601	6.954	28142.84	193442.6	0	101736	0	0.76	6.8736	14	1265.59	0.23475	0.003224
0632606	5	1.215414	36.732	148654.4	180676.7	0	471738	0	0.2	1.2154	64	5000	0.17558	0.014948
0632608	5	1.972041	0.424	1715.928	3383.88	0	92.9	0	0.391493	1.972	1	144.83	0.44058	2.94E-06
0634001	1	0.480356	14	56658	27216	0	9072	0	0.2	0.4804	81	5000	0.46066	0.000287
0635301	1	1.656721	0.8	3237.6	5363.8	0	6.8	0	0.275678	1.6567	3	340.828	0.54952	2.15E-07
0713618	2	7.206173	0.07	283.29	2041.437	-1	1500.15	0	0.76	7.2062	1	34.1251	0.6288	4.75E-05
0713705	1	0.911589	2	8094	7378.4	0	63945.9	0	0.2	0.9116	13	1155.59	0.74527	0.002026
0715007														
0715216														
0716701	1	3.160548	5.96	24120.12	76232.8	0	381.2	0	0.620319	3.1605	41	3149.01	0.6815	1.21E-05
0720506														
0720803	1	3.264146	0.02	80.94	264.2	0	15095.6	0	0.632369	3.2641	1	12.042	0.77661	0.000478
0721305														
0722107														
0722503	1	2.118853	0.02	80.94	171.5	0	76.2	0	0.433656	2.1189	1	4.11365	0.2653	2.41E-06
0722505	1	0.739139	2.3	9308.1	6879.977	-1	152.5	0	0.2	0.7391	10	687.077	0.38531	4.83E-06
0722705														
0723607	1	1.092826	0.3	1214.1	1326.8	0	3458.3	-1	0.2	1.0928	1	94.3365	0.4056	0.00011
0724206	2	2.802076	4	16188	45360	0	4536	0	0.571746	2.8021	13	1286.58	0.41487	0.000144
0724301														
0724804														
0724909														
0730407	2	6.170117	0.14	566.58	3495.865	-1	2.25	0	0.76	6.1701	1	44.8629	0.41333	7.13E-08
0730502	2	0.443036	0.38	1537.86	681.3278	-1	1.3	0	0.2	0.443	2	191.758	0.65089	4.12E-08
0730914	2	0.784861	0.3	1214.1	952.9	0	57.15	0	0.2	0.7849	2	54.1861	0.23297	1.81E-06
0731111	2	1.998306	0.07	283.29	566.1	0	200017	0	0.399491	1.9983	1	25.6057	0.47182	0.006338
0731405	1	1.657799	0.45	1821.15	3019.1	0	27.2	0	0.276149	1.6578	1	105.074	0.30118	8.62E-07
0731411														
0731412	1	1.412611	45.45	183936.2	259830.3	-1	22680	0	0.2	1.4126	76	5000	0.1419	0.000719
0731501	4	1.724851	0.015	60.705	104.7071	-1	13.2	0	0.304288	1.7249	1	3.92049	0.33712	4.18E-07
0731507	2	2.406243	11.82	47835.54	115104	0	1041.6	0	0.501297	2.4062	51	4877.82	0.53229	3.3E-05
0731514	7	2.453995	8.14286	32954.14	80869.29	0	754780	0	0.511001	2.454	52	3288.39	0.52089	0.023918
0731703														
0732110														
0732405														
0732510														
0733203	4	1.523818	0.2575	1042.103	1587.975	0	125	0	0.212505	1.5238	1	117.215	0.58714	3.96E-06
0733210	1	0.494234	18	72846	36003	0	1000.1	0	0.2	0.4942	50	4376.02	0.31358	3.17E-05
0733302	3	0.724101	0.07667	310.27	224.6667	0	259.2	0	0.2	0.7241	1	12.6393	0.21264	8.21E-06
0733404														
0733501	1	4.758418	0.07	283.29	1348.012	-1	9.1	0	0.747815	4.7584	1	34.6801	0.63903	2.88E-07
0733606	1	12.22724	11	44517	544320	0	22680	0	0.76	12.227	58	5000	0.58629	0.000719
0734604														
0735309	3	3.991179	0.33333	1349	5384.1	0	125797	0	0.699337	3.9912	2	151.078	0.5846	0.003986
0826707	1	0.646421	0.01	40.47	26.16064	-1	2.7	0	0.2	0.6464	1	2.71906	0.35072	8.56E-08
0830601														
0830903	4	3.759886	14.075	56961.53	214168.8	0	1390682	0	0.680841	3.7599	43	3142.22	0.28796	0.044068
0831102														
0831406	1	2.130921	8	32376	68990.7	0	5717.5	0	0.436863	2.1309	29	2034.52	0.32803	0.000181
0831904	10	1.16658	80	323760	377691.9	0	1132170	0	0.2	1.1666	52	5000	0.08062	0.035876
0832304														
0832510	3	2.623233	1.83667	7432.99	19498.47	0	500042	0	0.542549	2.6232	4	312.778	0.21966	0.015845
0832903	3	2.767227	40.3333	163229	451691.8	0	13608	0	0.566353	2.7672	55	5000	0.1599	0.000431
0832904	2	2.534016	0.92	3723.24	9434.75	0	94.35	0	0.526443	2.534	3	256.058	0.35899	2.99E-06
0832909	2	1.39064	0.745	3015.015	4192.8	0	4139.1	0	0.2	1.3906	4	369.892	0.64041	0.000131
0833001														

(continued)

Table 3A-1. (continued)

Surface Impoundment Industrial D Data									Surface Impoundment Calculated FRAMES Inputs					
IDNum	Total SI	Depth (m)	Average surface area (acres)	Average surface area (m2)	Average capacity (Mg)	Capacity replaced?	Average waste quantity (Mg)	Waste quantity replaced?	Fraction of SI occupied by sediments	Depth of SI (m)	Number of impellers/ aerators	Total power to impellers (HP)	Fraction surface area turbulent	Volumetric influent flow rate (m3/s)
		SrcDepth		SrcArea					d_setpt	d_wmu	n_imp	Powr	F_aer	Q_wmu
0833007	1	1.714187	2.72	11007.84	18869.5	0	1320.9	0	0.29996	1.7142	8	615.524	0.29189	4.19E-05
0834009	1	6.391418	2.01	8134.47	51990.8	0	2103.3	0	0.76	6.3914	12	1000.26	0.64188	6.66E-05
0923004														
0930205	1	3.2638	1	4047	13208.6	0	113217	0	0.63233	3.2638	3	289.846	0.37386	0.003588
0930301	1	1.882995	10	40470	76204.8	0	3810.2	0	0.362717	1.883	83	5000	0.64492	0.000121
0930702	9	5.053792	45.5556	184363.3	931734	0	88704	0	0.76	5.0538	73	5000	0.14157	0.002811
0932103	3	4.310886	2.16667	8768.5	37800	0	302400	0	0.721635	4.3109	5	515.144	0.30667	0.009582
0932507	4	1.659123	0.425	1719.975	2853.65	0	44.35	0	0.276726	1.6591	4	260.108	0.78941	1.41E-06
0932509	4	3.343123	3.2775	13264.04	44343.33	0	1487.68	0	0.641054	3.3431	9	588.811	0.23172	4.71E-05
0932903	7	1.120923	110.714	448060.7	502241.4	-1	629615	-1	0.2	1.1209	55	5000	0.05825	0.019951
0933704	1	1.520396	0.92	3723.24	5660.8	0	18.9	0	0.210732	1.5204	8	535.962	0.75142	5.99E-07
1010805														
1012203	8	1.787326	1.5	6070.5	10849.96	0	14152.1	0	0.328606	1.7873	3	290.887	0.25013	0.000448
1013209	2	0.498137	0.25	1011.75	503.9906	-1	264.15	0	0.2	0.4981	1	129.535	0.66832	8.37E-06
1014805														
1015510														
1023705	1	2.210711	4.64	18778.08	41512.9	0	294364	0	0.457188	2.2107	14	1383.05	0.38447	0.009328
1031503														
1031507	9	3.038619	17.7778	71946.67	218618.5	0	1677.29	0	0.605084	3.0386	64	5000	0.36277	5.32E-05
1032715	3	1.272039	7.33333	29678	37751.57	0	314492	0	0.2	1.272	24	1977.38	0.3478	0.009966
1032802	1	1.311353	16	64752	84912.7	0	180015	0	0.2	1.3114	58	5000	0.40308	0.005704
1033107	2	0.466259	1	4047	1886.95	0	60005	0	0.2	0.4663	2	186.272	0.24026	0.001901
1033114	1	2.260649	3.3	13355.1	30191.2	0	1037823	0	0.469179	2.2606	14	1461.86	0.57138	0.032887
1033202														
1033602	6	2.306754	1.58333	6407.75	14781.1	0	94347.5	0	0.479788	2.3068	5	515.703	0.42011	0.00299
1034005														
1034210	5	1.279623	1.8	7284.6	9321.54	0	52834.6	0	0.2	1.2796	8	848.348	0.60791	0.001674
1034406	2	1.51931	7.5	30352.5	46114.85	0	131143	0	0.210168	1.5193	32	3066.09	0.5273	0.004156
1034805	1	5.616281	0.44	1780.68	10000.8	0	200017	0	0.76	5.6163	3	242.582	0.71112	0.006338
1035117	1	1.748456	0.4	1618.8	2830.4	0	291345	0	0.31368	1.7485	1	118.041	0.38064	0.009232
1035405	3	2.206769	0.21	849.87	1875.467	0	37739	0	0.456219	2.2068	1	119.019	0.73103	0.001196
1035508	4	4.554747	1.8375	7436.363	33870.75	0	38493.8	0	0.736539	4.5547	3	385.108	0.27033	0.00122
1120904	1	1.299677	5.74	23229.78	30191.2	0	109443	0	0.2	1.2997	37	2953.88	0.66377	0.003468
1122705	2	16.43275	0.03	121.41	1995.1	0	14520.1	0	0.76	16.433	1	11.907	0.51194	0.00046
1131103	1	1.523818	1.03	4168.41	6351.9	0	721.2	0	0.212505	1.5238	7	585.746	0.73352	2.29E-05
1131802														
1133902														
1134405														
1212301	2	5.84781	0.575	2327.025	13608	0	13608	0	0.76	5.8478	2	254.33	0.57051	0.000431
1221704	2	1.551355	0.03	121.41	188.35	0	1008.28	-1	0.226483	1.5514	1	9.12361	0.39227	3.2E-05
1223404	6	0.485294	0.04833	195.605	94.92595	-1	0.03333	0	0.2	0.4853	1	13.0165	0.34737	1.06E-09
1230111	3	2.026844	1.37667	5571.37	11292.3	0	185976	0	0.407947	2.0268	8	556.003	0.52094	0.005893
1230206	4	0.987369	1.0625	4299.938	4245.625	0	707606	0	0.2	0.9874	7	591.178	0.71767	0.022423
1230517	12	1.759468	0.57417	2323.653	4088.392	0	43242.6	0	0.317976	1.7595	1	113.887	0.25584	0.00137
1230919														
1231101	2	1.165641	1	4047	4717.35	0	349086	0	0.2	1.1656	6	508.467	0.65584	0.011062
1231705	4	3.861116	1.9925	8063.648	31134.68	0	468907	0	0.689209	3.8611	6	665.508	0.43082	0.014859
1233101	1	3.067509	0.38	1537.86	4717.4	0	26.8	0	0.608803	3.0675	2	205.226	0.6966	8.49E-07
1235205	1	2.497794	0.28	1133.16	2830.4	0	15095.6	0	0.519576	2.4978	1	78.2748	0.36058	0.000478
1236637	1	0.560909	0.02	80.94	45.4	0	181.4	0	0.2	0.5609	1	9.62998	0.62106	5.75E-06
1236652	1	1.709909	0.03	121.41	207.6	0	100	0	0.298208	1.7099	1	14.221	0.61143	3.17E-06
1236732														
1236810														
1236820	1	9.591611	4	16188	155269	0	27216	0	0.76	9.5916	13	1391.37	0.44866	0.000862
1331103	3	1.060322	0.26667	1079.2	1144.3	0	42.3333	0	0.2	1.0603	1	66.755	0.32289	1.34E-06
1333001														
1333701														
1415407														
1421506														
1430107	2	1.146998	0.5	2023.5	2320.95	0	275.5	0	0.2	1.147	1	153.433	0.39581	8.73E-06
1430404	1	0.910099	0.41	1659.27	1510.1	0	1377474	0	0.2	0.9101	1	77.5044	0.24383	0.04365

(continued)

Table 3A-1. (continued)

Surface Impoundment Industrial D Data									Surface Impoundment Calculated FRAMES Inputs					
IDNum	Total SI	Depth (m)	Average surface area (acres)	Average surface area (m2)	Average capacity (Mg)	Capacity replaced?	Average waste quantity (Mg)	Waste quantity replaced?	Fraction of SI occupied by sediments	Depth of SI (m)	Number of impellers/ aerators	Total power to impellers (HP)	Fraction surface area turbulent	Volumetric influent flow rate (m3/s)
		SrcDepth		SrcArea					d_setpt	d_wmu	n_imp	Powr	F_aer	Q_wmu
1430602	2	1.119002	0.25	1011.75	1132.15	0	49060.7	0	0.2	1.119	1	121.519	0.62696	0.001555
1431515	20	0.427149	0.007	28.329	12.10072	-1	566.085	0	0.2	0.4271	1	4.29039	0.79056	1.79E-05
1434022	1	2.176098	0.03	121.41	264.2	0	943.5	0	0.448554	2.1761	1	8.66214	0.37243	2.99E-05
1434802	1	0.883617	0.15	607.05	536.4	0	2145.2	0	0.2	0.8836	0	89.4877	0.7695	6.8E-05
1435317														
1522504														
1530605	6	4.054426	1.91667	7756.75	31449.17	0	377390	0	0.704027	4.0544	11	1167.63	0.78577	0.011959
1530808	4	0.8605	0.225	910.575	783.55	0	30191.2	0	0.2	0.8605	1	37.3749	0.21426	0.000957
1532401														
1621808	2	2.069267	1.5	6070.5	12561.49	-1	32502.7	0	0.420085	2.0693	5	509.375	0.43801	0.00103
1630106	16	3.242903	0.79438	3214.836	10425.4	0	161806	0	0.629961	3.2429	5	341.184	0.55399	0.005127
1630401														
1631701	2	1.873679	0.54	2185.38	4094.7	0	634232	0	0.359549	1.8737	1	110.611	0.26421	0.020098
1632106	1	1.92332	4	16188	31134.7	0	31134.7	0	0.376079	1.9233	30	2093.15	0.67496	0.000987
1632703														
1633404	1	2.127032	2	8094	17216.2	0	245304	0	0.435834	2.127	11	1003.99	0.64749	0.007773
1633405	2	9.114597	0.155	627.285	5717.45	0	0.0025	0	0.76	9.1146	1	68.2371	0.56784	7.92E-11
1635404	1	8.504571	0.5	2023.5	17209	0	250021	0	0.76	8.5046	1	111.812	0.28844	0.007923
1721603	2	0.932493	0.25	1011.75	943.45	0	25002.1	0	0.2	0.9325	2	139.714	0.72084	0.000792

Appendix 3B

Aerated Tank Data

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Table 3B-1. TSDR Survey Wastewater Treatment Codes Used in Identifying Treatment Tanks

Process Code/Process Level		Aeration	Process Code/Process		Aeration Level
Equalization			**Filtration**		
1WT	Equalization	LO	34WT	Diatomaceous earth	NO
Cyanide oxidation			35WT	Sand	NO
2WT	Alkaline chlorination	LO	36WT	Multimedia	NO
3WT	Ozone	LO	37WT	Other filtration	NO
4WT	Electrochemical	LO	**Sludge dewatering**		
5WT	Other cyanide oxidation	LO	38WT	Gravity thickening	NO
General oxidation (including disinfection)			**Air flotation**		
6WT	Chlorination	LO	43WT	Dissolved air flotation	HI
7WT	Ozonation	LO	44WT	Partial aeration	HI
8WT	UV radiation	LO	45WT	Air dispersion	HI
9WT	Other general oxidation	LO	46WT	Other air flotation	HI
Chemical precipitation			**Oil skimming**		
10WT	Lime	LO	47WT	Gravity separation	NO
11WT	Sodium hydroxide	LO	48WT	Coalescing plate separation	NO
12WT	Soda ash	LO	49WT	Other oil skimming	NO
13WT	Sulfide	LO	**Other liquid-phase separation**		
14WT	Other chemical precipitation	LO	50WT	Decanting	NO
Chromium reduction			51WT	Other liquid phase-separation	NO
15WT	Sodium bisulfite	LO	**Biological treatment**		
16WT	Sulfur dioxide	LO	52WT	Activated sludge	HI
17WT	Ferrous sulfate	LO	54WT	Fixed film – rotating contactor	LO
18WT	Other chromium reduction	LO	57WT	Anaerobic	NO
19WT	Complexed metals treatment	LO	58WT	Other biological treatment	HI
Emulsion breaking			**Other wastewater treatment**		
20WT	Thermal	NO	60WT	Neutralization	LO
21WT	Chemical	LO	61WT	Nitrification	LO
22WT	Other emulsion breaking	LO	62WT	Denitrification	LO
Evaporation			63WT	Flocculation and/or coagulation	NO
31WT	Solar	NO	64WT	Settling (clarification)	NO
Fuel blending			66WT	Other wastewater treatment	LO
1FB	Fuel blending	LO	**Other Processes**		
			1TR	Other treatment	LO

Table 3B-2. Summary of Tank Information Collected by EPA on Aerated Wastewater Treatment

Company	Type of Unit	Type of Aerator	Aeration Level	Volume (m^3)	Area (m^2)	Depth (m)	Total hp	# Aer.	d_imp (cm)	w_imp (rad/s)	Q_air (m^3/s)	O_2 transfer rate (lb/hp-h)	hp/m^3 Tank Volume	Q_air/m^3 Tank Volume (1/s)	hp/Aer. for hp>100
Rielly Tar	Aerated lagoon	Mechanical	SI	3,369	2,109	1.60	30	2	14.0	367			0.009		
Texaco, IL	Bubbling pit	Diffused	HI	453	74	6.10					2.17			0.00479	
EWR	So eq. basin	Mechanical	LO	240	109	2.21	30	2	106.7	7.1			0.125		
EWR	No eq. basin	Mechanical	LO	191	84	2.29	20	1	152.4	5.9			0.105		
Summit	Mixing tank	Mechanical	LO	68	9	7.32	1.5	1	182.9	1.0			0.022		
Leaman	Mixing tank	Mechanical	LO	112	34	3.35	3	1					0.027		
Leaman	Aeration tank	Mechanical	HI	112	34	3.35	7.5	1					0.067		
Texaco, TX	Aerated lagoon	Mechanical	SI	45,425			1,800	28					0.040		64
LNVA	Eq. basin	Mechanical	LO	41,261	11,241	3.66	150	5	121.9	7.1			0.004		30
LNVA	Aeration tank	Mechanical	HI	41,261	11,241	3.66	900	9	259.1	188.5		3.0	0.022		100
LNVA	Aux. Aer. tank	Mechanical	HI	21,804	4,459	4.88	450	6	259.1	125.7		3.0	0.021		75
Neches	Aeration tank	Mechanical	HI	26,546	5,806	4.57	900	6	274.3				0.034		150
Shell, IL	Aerated lagoon	Mechanical	SI	24,975	5,853	4.27	270	6	41.9	123.0			0.011		45
Sun, OK	Aeration tank	Mechanical	HI	3,367	910	3.70	150	2	50	123.6		3.0	0.045		75
Plant A3	Aeration tank	Diffused	HI	5,764	1,051	5.49					2.35			0.00041	
Plant A2	Aeration tank	Diffused	HI	5,830							3.78			0.00065	
Plant A2	Aeration tank	Mechanical	HI	1,211											
Plant A1	Eq. basin	Mechanical	LO	681	200	3.40									
Plant A1	Aeration tank	Diffused	HI	1,666	159	10.46					0.80			0.00048	
Amoco	Aeration tank	Mechanical	HI	5,678	931	6.10	300	3					0.053		100
El DuPont	Aeration tank	Diffused	HI	4,542	618	7.36									
Mobay	Aeration tank	Diffused	HI	3,785	730	5.19									
Borg-Warner	Aeration tank	Diffused	HI	6,814							4.72			0.00069	
TSDF -T01G	Aerated trt. tank	Mechanical	HI	108	27	4.00	7.5						0.069		
TSDF -T01H	Aerated trt. tank	Mechanical	HI	1,600	430	3.70	120						0.075		
TSDF -T01A	Treatment tank		LO	30	13	2.40									
TSDF -T01B	Treatment tank		LO	76	26	2.70									
TSDF -T01C	Treatment tank		LO	800	65	12.00									
Average									146.2	105.4			0.0416	0.0014	79.9
Median									137.2	123.0			0.0303	0.0006	75.0

Table 3B-3. Correlated Tank Data from TSDR Survey

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
1	HI	300	1.14	8.15E-05	1.03	1.11	1.53	0.691	0.250	1
2	HI	400	1.51	1.62E-03	1.25	1.21	0.90	0.633	0.250	1
3	HI	850	3.22	2.40E-07	1.28	2.51	1.78	0.929	0.250	1
4	HI	1,000	3.79	7.20E-07	1.44	2.62	1.94	0.787	0.250	1
5	HI	3,200	12.11	2.24E-04	2.90	4.18	3.40	0.691	0.259	1
6	HI	5,125	19.40	1.26E-04	2.47	7.87	2.97	0.800	0.847	1
7	HI	5,880	22.26	1.49E-03	2.16	10.31	2.66	0.834	0.922	1
8	HI	10,200	38.61	1.63E-04	3.27	11.81	3.77	0.558	1.031	1
9	HI	10,200	38.61	1.70E-03	2.66	14.51	3.16	0.761	1.133	1
10	HI	15,000	56.78	8.15E-05	3.26	17.39	1.40	0.783	1.544	1
11	HI	13,900	52.62	3.51E-04	2.90	18.16	3.40	0.647	1.447	1
12	HI	20,000	75.71	1.02E-03	2.97	25.51	3.47	0.762	2.357	1
13	HI	30,370	114.96	8.40E-04	4.01	28.65	0.80	0.922	2.129	1
14	HI	21,000	79.49	3.56E-03	2.76	28.79	3.26	0.630	2.250	1
15	HI	31,300	118.48	5.97E-03	3.21	36.94	3.71	0.707	3.331	1
16	HI	196,000	741.94	1.70E-03	4.87	152.50	5.10	0.785	18.478	1
17	HI	225,000	851.71	2.40E-06	3.58	237.62	4.08	0.811	22.185	1
18	HI	415,600	1,573.21	3.92E-03	3.70	424.73	4.20	0.765	32.900	1
19	HI	640,000	2,422.65	2.06E-01	4.16	582.44	4.66	0.651	48.541	1
20	HI	640,000	2,422.65	2.06E-01	3.39	714.37	3.89	0.745	58.856	2
21	HI	1,800,000	6,813.72	8.64E-02	5.17	1,319.02	5.67	0.898	273.136	4
22	HI	3,000,000	11,356.19	9.15E-01	5.54	2,049.16	6.04	0.706	330.106	4
23	HI	6,000,000	22,712.39	9.15E-01	4.80	4,734.60	5.30	0.849	829.287	9
24	HI	4,624,000	17,503.68	4.71E-01	5.06	3,455.96	5.56	0.655	649.233	7
25	HI	4,624,000	17,503.68	4.71E-01	3.77	4,644.58	4.27	0.732	555.704	9
26	HI	4,624,000	17,503.68	4.71E-01	3.46	5,054.12	0.60	0.585	317.706	4
27	HI	8,200,000	31,040.27	3.88E-01	3.68	8,430.73	4.18	0.810	890.808	12
28	HI	8,200,000	31,040.27	3.29E-01	3.67	8,452.59	4.17	0.713	1,164.902	13
29	HI	3,000,000	11,356.19	9.15E-01	3.38	3,361.45	1.50	0.720	263.739	3
30	LO	120	0.45	5.15E-04	0.90	0.50	1.40	0.342	0.250	1
31	LO	100	0.38	1.34E-04	0.74	0.51	1.24	0.582	0.250	1
32	LO	150	0.57	2.75E-05	1.04	0.55	1.54	0.760	0.250	1
33	LO	100	0.38	8.30E-05	0.69	0.55	1.19	0.553	0.250	1
34	LO	100	0.38	8.30E-05	0.69	0.55	1.19	0.393	0.250	1
35	LO	110	0.42	1.78E-07	0.75	0.55	1.25	0.506	0.250	1
36	LO	120	0.45	5.15E-04	0.76	0.60	1.26	0.678	0.250	1
37	LO	100	0.38	1.80E-08	0.63	0.60	1.13	0.797	0.250	1
38	LO	150	0.57	2.40E-07	0.92	0.62	1.42	0.631	0.250	1
39	LO	150	0.57	2.40E-07	0.90	0.63	1.40	0.786	0.250	1
40	LO	125	0.47	1.49E-08	0.72	0.65	1.22	0.287	0.250	1
41	LO	200	0.76	2.55E-04	1.14	0.66	1.64	0.368	0.250	1
42	LO	200	0.76	5.48E-04	1.09	0.69	0.80	0.292	0.250	1
43	LO	150	0.57	2.40E-07	0.80	0.71	1.30	0.518	0.250	1
44	LO	180	0.68	1.80E-07	0.95	0.72	1.45	0.659	0.250	1
45	LO	215	0.81	1.64E-06	1.08	0.75	1.58	0.471	0.250	1
46	LO	150	0.57	1.50E-05	0.72	0.79	1.22	0.319	0.250	1
47	LO	200	0.76	2.55E-04	0.91	0.83	1.41	0.274	0.250	1
48	LO	230	0.87	1.64E-06	1.01	0.86	1.51	0.200	0.250	1
49	LO	185	0.70	5.48E-04	0.81	0.86	1.31	0.640	0.250	1

(continued)

Table 3B-3. (continued)

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
50	LO	235	0.89	1.44E-08	0.99	0.90	1.10	0.551	0.250	1
51	LO	200	0.76	1.64E-06	0.83	0.91	1.33	0.622	0.250	1
52	LO	400	1.51	2.40E-05	1.64	0.92	2.14	0.730	0.250	1
53	LO	210	0.79	1.44E-08	0.84	0.94	1.34	0.311	0.250	1
54	LO	210	0.79	1.44E-08	0.82	0.96	1.32	0.584	0.250	1
55	LO	200	0.76	1.20E-07	0.76	0.99	1.26	0.268	0.250	1
56	LO	250	0.95	1.46E-06	0.93	1.01	1.43	0.716	0.250	1
57	LO	350	1.32	6.72E-07	1.28	1.04	1.78	0.591	0.250	1
58	LO	350	1.32	6.72E-07	1.23	1.07	0.50	0.316	0.250	1
59	LO	300	1.14	6.10E-05	1.05	1.08	1.55	0.371	0.250	1
60	LO	350	1.32	6.72E-07	1.22	1.08	1.72	0.407	0.250	1
61	LO	400	1.51	1.40E-04	1.32	1.15	1.82	0.414	0.250	1
62	LO	350	1.32	6.72E-07	1.14	1.16	1.64	0.461	0.250	1
63	LO	350	1.32	6.72E-07	1.08	1.23	1.58	0.567	0.250	1
64	LO	350	1.32	6.72E-07	1.06	1.24	1.56	0.253	0.250	1
65	LO	450	1.70	9.31E-06	1.37	1.25	1.87	0.367	0.250	1
66	LO	450	1.70	2.24E-04	1.30	1.31	1.80	0.669	0.250	1
67	LO	550	2.08	2.15E-06	1.56	1.33	2.06	0.443	0.250	1
68	LO	500	1.89	7.65E-05	1.41	1.34	1.91	0.557	0.250	1
69	LO	475	1.80	4.80E-07	1.33	1.35	1.70	0.800	0.250	1
70	LO	530	2.01	1.68E-04	1.42	1.41	1.92	0.430	0.250	1
71	LO	400	1.51	2.40E-05	1.07	1.42	0.50	0.771	0.250	1
72	LO	500	1.89	1.45E-07	1.33	1.42	0.50	0.285	0.250	1
73	LO	450	1.70	2.24E-04	1.17	1.46	1.67	0.310	0.250	1
74	LO	500	1.89	1.09E-03	1.29	1.47	1.79	0.480	0.250	1
75	LO	550	2.08	1.67E-06	1.42	1.47	1.92	0.441	0.250	1
76	LO	550	2.08	2.15E-06	1.40	1.49	1.90	0.521	0.250	1
77	LO	500	1.89	3.60E-07	1.26	1.51	1.76	0.800	0.250	1
78	LO	500	1.89	1.67E-06	1.26	1.51	1.76	0.415	0.250	1
79	LO	600	2.27	7.48E-07	1.50	1.51	2.00	0.482	0.250	1
80	LO	600	2.27	2.57E-03	1.50	1.51	2.00	0.232	0.250	1
81	LO	435	1.65	1.20E-07	1.08	1.52	1.58	0.551	0.250	1
82	LO	500	1.89	7.80E-06	1.24	1.53	1.74	0.495	0.250	1
83	LO	500	1.89	1.10E-04	1.23	1.54	1.73	0.633	0.250	1
84	LO	475	1.80	1.67E-06	1.17	1.54	0.50	0.472	0.250	1
85	LO	636	2.41	2.56E-03	1.53	1.57	2.03	0.594	0.250	1
86	LO	500	1.89	7.20E-07	1.20	1.58	1.70	0.200	0.250	1
87	LO	430	1.63	2.40E-10	1.03	1.59	1.53	0.256	0.250	1
88	LO	600	2.27	1.71E-03	1.43	1.59	1.93	0.683	0.250	1
89	LO	500	1.89	2.40E-05	1.16	1.64	1.66	0.284	0.250	1
90	LO	500	1.89	6.00E-07	1.15	1.65	1.65	0.800	0.250	1
91	LO	500	1.89	3.68E-05	1.14	1.66	0.80	0.589	0.250	1
92	LO	500	1.89	1.09E-03	1.13	1.67	1.63	0.800	0.250	1
93	LO	327	1.24	1.44E-08	0.73	1.71	1.23	0.667	0.250	1
94	LO	500	1.89	3.60E-06	1.11	1.71	1.61	0.200	0.250	1
95	LO	670	2.54	2.77E-06	1.48	1.71	1.98	0.384	0.250	1
96	LO	600	2.27	7.48E-07	1.32	1.73	1.82	0.210	0.250	1
97	LO	500	1.89	2.71E-04	1.10	1.73	1.60	0.455	0.250	1
98	LO	600	2.27	5.33E-04	1.30	1.74	1.80	0.346	0.250	1

(continued)

Table 3B-3. (continued)

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
99	LO	500	1.89	4.68E-05	1.07	1.77	1.57	0.235	0.250	1
100	LO	600	2.27	5.62E-04	1.24	1.83	1.74	0.733	0.250	1
101	LO	650	2.46	1.09E-03	1.34	1.83	0.60	0.271	0.250	1
102	LO	670	2.54	4.08E-06	1.37	1.86	1.87	0.714	0.250	1
103	LO	600	2.27	7.48E-07	1.22	1.86	1.72	0.273	0.250	1
104	LO	500	1.89	1.29E-06	1.00	1.90	1.50	0.589	0.250	1
105	LO	800	3.03	2.13E-05	1.59	1.91	2.09	0.358	0.250	1
106	LO	1,000	3.79	5.62E-05	1.96	1.93	2.46	0.564	0.250	1
107	LO	900	3.41	4.80E-07	1.74	1.96	0.50	0.623	0.250	1
108	LO	600	2.27	2.57E-03	1.15	1.97	1.65	0.363	0.250	1
109	LO	750	2.84	9.00E-06	1.42	2.00	1.92	0.258	0.250	1
110	LO	500	1.89	8.16E-04	0.94	2.01	1.44	0.535	0.250	1
111	LO	600	2.27	5.49E-04	1.12	2.02	1.62	0.200	0.250	1
112	LO	800	3.03	1.86E-03	1.49	2.03	1.99	0.569	0.250	1
113	LO	790	2.99	1.64E-06	1.47	2.04	1.97	0.446	0.250	1
114	LO	1,000	3.79	3.60E-03	1.85	2.05	2.35	0.598	0.250	1
115	LO	636	2.41	1.62E-04	1.17	2.05	1.67	0.220	0.250	1
116	LO	800	3.03	4.42E-03	1.47	2.06	1.97	0.466	0.250	1
117	LO	1,000	3.79	1.01E-06	1.82	2.08	2.32	0.431	0.250	1
118	LO	800	3.03	2.13E-05	1.45	2.09	1.95	0.289	0.250	1
119	LO	1,160	4.39	1.50E-05	2.09	2.10	2.59	0.305	0.250	1
120	LO	1,000	3.79	1.20E-05	1.79	2.11	2.29	0.671	0.250	1
121	LO	748	2.83	2.69E-05	1.32	2.15	1.82	0.519	0.250	1
122	LO	748	2.83	2.69E-05	1.32	2.15	1.82	0.257	0.250	1
123	LO	675	2.56	1.38E-04	1.14	2.24	1.64	0.444	0.250	1
124	LO	1,008	3.82	3.92E-03	1.65	2.31	2.15	0.611	0.250	1
125	LO	1,041	3.94	9.60E-07	1.68	2.35	2.18	0.702	0.250	1
126	LO	934	3.54	9.23E-05	1.50	2.36	2.00	0.237	0.250	1
127	LO	1,000	3.79	1.10E-04	1.59	2.38	2.09	0.363	0.250	1
128	LO	1,000	3.79	3.60E-03	1.54	2.46	2.04	0.505	0.250	1
129	LO	1,000	3.79	6.69E-03	1.53	2.47	2.03	0.511	0.250	1
130	LO	1,041	3.94	7.50E-06	1.57	2.50	2.07	0.547	0.250	1
131	LO	800	3.03	4.29E-05	1.21	2.51	1.71	0.200	0.250	1
132	LO	1,000	3.79	6.90E-06	1.50	2.53	2.00	0.524	0.250	1
133	LO	1,200	4.54	6.00E-07	1.78	2.55	2.28	0.780	0.250	1
134	LO	1,000	3.79	3.60E-03	1.46	2.59	1.96	0.800	0.250	1
135	LO	1,100	4.16	1.38E-04	1.59	2.63	2.09	0.297	0.250	1
136	LO	1,400	5.30	5.76E-02	2.01	2.64	0.90	0.200	0.250	1
137	LO	1,100	4.16	9.02E-04	1.57	2.65	2.07	0.200	0.250	1
138	LO	1,500	5.68	6.00E-05	2.13	2.67	2.63	0.663	0.250	1
139	LO	1,000	3.79	4.08E-07	1.42	2.67	1.92	0.203	0.250	1
140	LO	1,000	3.79	2.88E-06	1.41	2.68	1.91	0.260	0.250	1
141	LO	1,000	3.79	2.32E-06	1.40	2.70	1.90	0.624	0.250	1
142	LO	1,050	3.97	1.10E-04	1.47	2.71	1.97	0.234	0.250	1
143	LO	1,000	3.79	1.08E-03	1.37	2.75	1.87	0.646	0.250	1
144	LO	1,400	5.30	6.52E-04	1.92	2.77	2.42	0.520	0.250	1
145	LO	1,000	3.79	1.58E-05	1.36	2.79	1.86	0.334	0.250	1
146	LO	1,500	5.68	1.62E-04	2.01	2.82	2.51	0.450	0.250	1
147	LO	1,615	6.11	1.35E-03	2.12	2.88	2.62	0.287	0.250	1

(continued)

Table 3B-3. (continued)

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
148	LO	950	3.60	1.08E-03	1.25	2.88	1.75	0.393	0.250	1
149	LO	1,500	5.68	6.24E-03	1.95	2.91	2.45	0.684	0.250	1
150	LO	1,400	5.30	1.20E-08	1.81	2.93	0.50	0.773	0.250	1
151	LO	1,269	4.80	2.07E-02	1.63	2.95	2.13	0.368	0.250	1
152	LO	1,200	4.54	1.89E-04	1.53	2.97	2.03	0.496	0.250	1
153	LO	1,800	6.81	2.30E-07	2.23	3.05	2.73	0.524	0.250	1
154	LO	2,000	7.57	6.24E-03	2.48	3.06	2.98	0.552	0.250	1
155	LO	1,270	4.81	4.37E-03	1.55	3.11	2.05	0.540	0.250	1
156	LO	1,800	6.81	2.30E-07	2.18	3.12	2.68	0.592	0.250	1
157	LO	1,350	5.11	4.80E-07	1.64	3.12	2.14	0.742	0.250	1
158	LO	1,800	6.81	2.30E-07	2.16	3.15	2.66	0.200	0.250	1
159	LO	1,870	7.08	3.15E-03	2.23	3.17	2.73	0.627	0.250	1
160	LO	1,800	6.81	2.30E-07	2.15	3.17	2.65	0.528	0.250	1
161	LO	1,450	5.49	1.33E-04	1.72	3.19	2.22	0.292	0.250	1
162	LO	1,000	3.79	1.45E-03	1.17	3.23	1.67	0.378	0.250	1
163	LO	2,000	7.57	6.40E-06	2.29	3.30	2.79	0.491	0.250	1
164	LO	1,650	6.25	2.76E-03	1.86	3.36	0.60	0.295	0.250	1
165	LO	1,800	6.81	1.44E-05	2.02	3.38	2.52	0.352	0.250	1
166	LO	1,600	6.06	1.24E-03	1.79	3.39	2.29	0.427	0.250	1
167	LO	1,400	5.30	3.54E-05	1.56	3.40	1.40	0.545	0.250	1
168	LO	1,800	6.81	1.73E-04	1.99	3.42	2.49	0.529	0.250	1
169	LO	2,150	8.14	9.01E-04	2.35	3.46	2.85	0.790	0.250	1
170	LO	1,800	6.81	2.30E-07	1.96	3.48	2.30	0.542	0.250	1
171	LO	1,500	5.68	6.15E-03	1.58	3.59	2.08	0.289	0.250	1
172	LO	2,550	9.65	5.48E-04	2.65	3.64	3.15	0.273	0.250	1
173	LO	2,000	7.57	1.82E-03	2.05	3.69	2.55	0.495	0.250	1
174	LO	1,800	6.81	2.30E-07	1.82	3.74	2.32	0.312	0.250	1
175	LO	2,000	7.57	1.80E-05	1.97	3.84	1.90	0.350	0.250	1
176	LO	3,000	11.36	6.24E-06	2.94	3.86	3.44	0.538	0.250	1
177	LO	2,000	7.57	1.09E-03	1.95	3.88	2.45	0.493	0.250	1
178	LO	2,000	7.57	1.53E-04	1.95	3.89	2.45	0.726	0.250	1
179	LO	2,000	7.57	1.44E-06	1.93	3.92	2.43	0.599	0.250	1
180	LO	2,000	7.57	4.80E-07	1.93	3.92	2.43	0.443	0.250	1
181	LO	2,290	8.67	4.99E-05	2.19	3.97	2.69	0.416	0.250	1
182	LO	2,000	7.57	2.19E-02	1.90	3.99	2.40	0.501	0.250	1
183	LO	2,100	7.95	2.16E-06	1.99	4.00	2.49	0.286	0.250	1
184	LO	2,000	7.57	2.40E-05	1.88	4.03	2.38	0.323	0.250	1
185	LO	2,000	7.57	1.39E-05	1.86	4.06	2.36	0.800	0.250	1
186	LO	2,300	8.71	1.35E-03	2.13	4.08	2.63	0.548	0.250	1
187	LO	2,200	8.33	4.42E-03	2.03	4.10	1.30	0.436	0.250	1
188	LO	3,000	11.36	4.80E-05	2.76	4.11	3.00	0.276	0.250	1
189	LO	1,800	6.81	2.16E-06	1.62	4.21	2.12	0.639	0.250	1
190	LO	2,000	7.57	2.44E-05	1.79	4.23	2.29	0.546	0.250	1
191	LO	2,500	9.46	2.80E-02	2.22	4.26	2.72	0.684	0.250	1
192	LO	2,800	10.60	5.61E-06	2.48	4.28	1.20	0.552	0.250	1
193	LO	2,150	8.14	9.01E-04	1.88	4.33	2.38	0.478	0.250	1
194	LO	2,500	9.46	3.43E-03	2.17	4.36	2.67	0.306	0.250	1
195	LO	2,000	7.57	4.80E-06	1.69	4.47	1.20	0.321	0.250	1
196	LO	3,230	12.23	6.67E-04	2.69	4.55	2.60	0.350	0.250	1

(continued)

Table 3B-3. (continued)

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
197	LO	3,000	11.36	1.44E-06	2.49	4.57	2.99	0.507	0.250	1
198	LO	2,400	9.08	6.67E-04	1.96	4.64	2.46	0.800	0.250	1
199	LO	2,500	9.46	1.44E-05	2.03	4.66	2.53	0.480	0.250	1
200	LO	3,000	11.36	1.01E-02	2.43	4.67	2.93	0.465	0.250	1
201	LO	2,000	7.57	1.15E-04	1.62	4.67	1.90	0.593	0.250	1
202	LO	2,500	9.46	2.80E-02	2.02	4.68	1.10	0.453	0.250	1
203	LO	2,500	9.46	1.38E-07	2.02	4.68	2.52	0.474	0.250	1
204	LO	3,100	11.73	1.33E-02	2.50	4.69	3.00	0.470	0.250	1
205	LO	3,000	11.36	1.09E-03	2.42	4.69	2.92	0.561	0.250	1
206	LO	2,220	8.40	1.35E-03	1.79	4.70	2.29	0.555	0.250	1
207	LO	3,000	11.36	4.80E-05	2.38	4.76	2.88	0.355	0.250	1
208	LO	2,400	9.08	1.73E-04	1.89	4.79	0.50	0.527	0.250	1
209	LO	2,550	9.65	5.48E-04	2.01	4.81	0.50	0.678	0.250	1
210	LO	3,800	14.38	7.32E-06	2.94	4.89	3.44	0.574	0.250	1
211	LO	3,300	12.49	2.55E-04	2.54	4.92	3.04	0.675	0.250	1
212	LO	3,000	11.36	3.66E-05	2.31	4.92	2.81	0.472	0.250	1
213	LO	2,700	10.22	2.64E-06	2.08	4.92	2.58	0.592	0.250	1
214	LO	3,000	11.36	1.01E-02	2.30	4.93	0.60	0.623	0.250	1
215	LO	3,000	11.36	1.44E-06	2.29	4.96	2.79	0.555	0.250	1
216	LO	2,400	9.08	5.22E-03	1.81	5.01	2.31	0.380	0.250	1
217	LO	3,100	11.73	4.96E-03	2.33	5.04	2.83	0.472	0.250	1
218	LO	4,000	15.14	1.36E-06	2.99	5.06	3.49	0.434	0.250	1
219	LO	3,300	12.49	2.55E-04	2.47	5.06	2.97	0.746	0.250	1
220	LO	2,400	9.08	1.40E-04	1.79	5.09	2.29	0.603	0.250	1
221	LO	3,100	11.73	1.98E-05	2.30	5.10	2.80	0.441	0.250	1
222	LO	3,800	14.38	6.14E-06	2.81	5.12	3.31	0.322	0.250	1
223	LO	3,400	12.87	1.90E-03	2.50	5.14	3.00	0.482	0.250	1
224	LO	3,100	11.73	5.01E-03	2.25	5.21	0.90	0.514	0.250	1
225	LO	3,100	11.73	1.98E-05	2.24	5.23	2.74	0.330	0.250	1
226	LO	3,500	13.25	1.09E-02	2.50	5.31	3.00	0.608	0.250	1
227	LO	3,384	12.81	2.07E-02	2.40	5.33	2.90	0.754	0.250	1
228	LO	3,000	11.36	1.08E-04	2.13	5.34	2.63	0.617	0.250	1
229	LO	2,500	9.46	3.43E-03	1.76	5.37	2.26	0.360	0.250	1
230	LO	4,000	15.14	1.50E-05	2.80	5.40	3.30	0.512	0.250	1
231	LO	3,000	11.36	1.82E-03	2.09	5.44	0.50	0.800	0.250	1
232	LO	3,000	11.36	7.20E-06	2.09	5.44	2.59	0.527	0.250	1
233	LO	3,000	11.36	1.08E-04	2.06	5.51	2.56	0.475	0.250	1
234	LO	3,000	11.36	6.24E-03	2.05	5.53	2.55	0.712	0.250	1
235	LO	2,200	8.33	4.42E-03	1.50	5.54	0.90	0.665	0.250	1
236	LO	4,000	15.14	2.11E-04	2.71	5.59	3.21	0.255	0.250	1
237	LO	4,100	15.52	8.17E-03	2.77	5.60	3.27	0.515	0.250	1
238	LO	4,000	15.14	1.36E-06	2.67	5.68	3.17	0.200	0.250	1
239	LO	3,350	12.68	2.49E-01	2.21	5.73	2.71	0.304	0.250	1
240	LO	4,200	15.90	9.86E-03	2.73	5.83	3.23	0.455	0.250	1
241	LO	4,200	15.90	9.86E-03	2.73	5.83	3.23	0.257	0.250	1
242	LO	2,000	7.57	1.90E-03	1.27	5.96	1.77	0.514	0.250	1
243	LO	3,400	12.87	8.17E-03	2.15	5.98	2.65	0.376	0.250	1
244	LO	4,320	16.35	9.23E-05	2.73	5.98	3.23	0.200	0.250	1
245	LO	4,000	15.14	4.71E-05	2.49	6.08	2.99	0.631	0.250	1

(continued)

Table 3B-3. (continued)

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
246	LO	5,000	18.93	1.92E-05	3.11	6.09	3.61	0.622	0.250	1
247	LO	4,000	15.14	1.50E-05	2.47	6.13	2.30	0.273	0.250	1
248	LO	4,000	15.14	1.80E-05	2.47	6.13	2.97	0.469	0.250	1
249	LO	3,500	13.25	7.75E-05	2.16	6.14	2.66	0.493	0.250	1
250	LO	4,000	15.14	6.04E-05	2.45	6.17	2.95	0.439	0.250	1
251	LO	3,600	13.63	4.29E-04	2.19	6.21	2.69	0.200	0.250	1
252	LO	4,200	15.90	9.86E-03	2.53	6.28	3.03	0.526	0.250	1
253	LO	3,945	14.93	1.53E-04	2.37	6.31	2.87	0.800	0.250	1
254	LO	3,600	13.63	4.29E-04	2.15	6.33	2.65	0.217	0.250	1
255	LO	4,600	17.41	1.38E-03	2.72	6.39	3.22	0.575	0.250	1
256	LO	4,000	15.14	1.36E-06	2.34	6.48	2.84	0.800	0.250	1
257	LO	4,000	15.14	6.24E-03	2.32	6.53	2.82	0.425	0.250	1
258	LO	4,700	17.79	2.18E-05	2.70	6.59	1.60	0.251	0.250	1
259	LO	4,000	15.14	1.36E-06	2.29	6.61	2.79	0.369	0.250	1
260	LO	3,445	13.04	4.20E-03	1.93	6.74	2.43	0.321	0.250	1
261	LO	4,000	15.14	5.61E-06	2.24	6.77	2.74	0.795	0.250	1
262	LO	4,300	16.28	1.40E-02	2.40	6.78	2.90	0.586	0.250	1
263	LO	4,400	16.66	3.60E-03	2.41	6.90	2.91	0.290	0.250	1
264	LO	5,000	18.93	1.23E-04	2.74	6.91	3.24	0.552	0.250	1
265	LO	4,500	17.03	9.36E-06	2.44	6.99	2.94	0.573	0.250	1
266	LO	5,000	18.93	3.00E-05	2.70	7.02	2.10	0.200	0.250	1
267	LO	3,780	14.31	1.38E-07	2.02	7.10	2.52	0.433	0.250	1
268	LO	4,200	15.90	4.68E-07	2.20	7.24	2.70	0.295	0.250	1
269	LO	5,800	21.96	4.80E-04	3.02	7.27	3.50	0.200	0.250	1
270	LO	5,000	18.93	2.76E-06	2.59	7.30	3.09	0.347	0.250	1
271	LO	5,800	21.96	2.52E-02	3.00	7.31	3.50	0.620	0.250	1
272	LO	4,700	17.79	2.42E-05	2.42	7.34	2.92	0.238	0.250	1
273	LO	5,000	18.93	1.23E-04	2.56	7.40	3.06	0.381	0.250	1
274	LO	4,000	15.14	9.60E-05	2.04	7.41	2.54	0.273	0.250	1
275	LO	5,800	21.96	2.52E-02	2.93	7.49	3.43	0.800	0.274	1
276	LO	5,400	20.44	1.84E-04	2.68	7.62	3.18	0.304	0.250	1
277	LO	5,500	20.82	8.11E-03	2.70	7.70	3.20	0.467	0.250	1
278	LO	4,320	16.35	9.23E-05	2.11	7.74	2.60	0.694	0.250	1
279	LO	4,320	16.35	9.23E-05	2.10	7.78	2.60	0.610	0.250	1
280	LO	4,500	17.03	1.82E-03	2.19	7.79	0.50	0.427	0.250	1
281	LO	5,600	21.20	3.15E-04	2.67	7.94	1.90	0.338	0.250	1
282	LO	5,000	18.93	4.99E-05	2.38	7.95	0.50	0.536	0.250	1
283	LO	5,000	18.93	7.41E-05	2.34	8.10	2.84	0.654	0.254	1
284	LO	6,000	22.71	1.07E-02	2.78	8.18	3.28	0.784	0.250	1
285	LO	5,000	18.93	7.41E-05	2.31	8.20	0.90	0.403	0.250	1
286	LO	5,000	18.93	4.37E-03	2.27	8.34	2.77	0.402	0.250	1
287	LO	7,500	28.39	1.78E-05	3.34	8.50	3.84	0.413	0.250	1
288	LO	5,000	18.93	4.68E-05	2.21	8.56	2.71	0.323	0.250	1
289	LO	5,000	18.93	1.92E-05	2.21	8.58	2.71	0.445	0.250	1
290	LO	7,100	26.88	3.53E-06	3.12	8.61	3.62	0.460	0.250	1
291	LO	4,500	17.03	6.79E-03	1.97	8.66	2.47	0.403	0.250	1
292	LO	5,000	18.93	2.76E-06	2.18	8.69	2.68	0.492	0.250	1
293	LO	6,000	22.71	4.80E-06	2.56	8.86	3.06	0.411	0.250	1

(continued)

Table 3B-3. (continued)

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
294	LO	6,000	22.71	8.01E-04	2.51	9.05	3.01	0.466	0.275	1
295	LO	6,000	22.71	8.01E-04	2.50	9.07	3.00	0.561	0.250	1
296	LO	6,390	24.19	4.64E-03	2.65	9.11	3.15	0.624	0.250	1
297	LO	6,850	25.93	5.04E-03	2.80	9.25	3.30	0.349	0.250	1
298	LO	4,700	17.79	2.42E-05	1.92	9.27	2.42	0.316	0.250	1
299	LO	8,000	30.28	2.27E-05	3.27	9.27	3.77	0.442	0.283	1
300	LO	4,000	15.14	2.74E-05	1.63	9.28	2.13	0.750	0.250	1
301	LO	6,500	24.61	4.77E-03	2.60	9.47	3.10	0.483	0.250	1
302	LO	7,000	26.50	1.24E-03	2.77	9.56	0.70	0.598	0.250	1
303	LO	4,000	15.14	1.80E-04	1.56	9.72	2.06	0.494	0.250	1
304	LO	7,500	28.39	1.87E-05	2.91	9.77	3.41	0.251	0.250	1
305	LO	7,000	26.50	8.20E-05	2.64	10.05	3.14	0.613	0.250	1
306	LO	9,000	34.07	7.74E-04	3.36	10.15	3.86	0.545	0.280	1
307	LO	7,500	28.39	1.78E-05	2.77	10.25	3.27	0.347	0.250	1
308	LO	8,000	30.28	2.68E-02	2.86	10.58	3.36	0.581	0.348	1
309	LO	7,000	26.50	9.72E-06	2.51	10.58	3.01	0.479	0.250	1
310	LO	7,500	28.39	1.46E-05	2.68	10.58	3.18	0.734	0.302	1
311	LO	7,680	29.07	2.41E-03	2.74	10.60	3.24	0.533	0.279	1
312	LO	8,500	32.18	4.48E-03	3.02	10.67	3.52	0.302	0.306	1
313	LO	6,171	23.36	1.60E-01	2.18	10.72	2.68	0.695	0.250	1
314	LO	7,000	26.50	2.93E-03	2.47	10.74	2.97	0.445	0.250	1
315	LO	7,000	26.50	1.09E-02	2.46	10.77	2.96	0.627	0.250	1
316	LO	6,800	25.74	2.81E-03	2.38	10.83	1.00	0.583	0.250	1
317	LO	7,500	28.39	1.73E-03	2.61	10.88	3.11	0.620	0.250	1
318	LO	7,000	26.50	1.87E-05	2.43	10.92	2.93	0.456	0.300	1
319	LO	5,800	21.96	4.80E-04	2.01	10.94	2.51	0.368	0.250	1
320	LO	9,000	34.07	7.74E-04	3.11	10.95	3.61	0.303	0.327	1
321	LO	7,500	28.39	1.87E-05	2.59	10.96	3.09	0.541	0.311	1
322	LO	7,000	26.50	2.93E-03	2.41	11.00	2.91	0.516	0.250	1
323	LO	6,800	25.74	2.81E-03	2.33	11.06	1.50	0.765	0.250	1
324	LO	7,500	28.39	6.55E-06	2.56	11.07	3.06	0.538	0.285	1
325	LO	7,500	28.39	1.46E-05	2.55	11.12	3.05	0.478	0.314	1
326	LO	8,000	30.28	1.60E-01	2.70	11.23	3.20	0.738	0.250	1
327	LO	11,200	42.40	1.34E-03	3.75	11.29	4.25	0.553	0.250	1
328	LO	9,000	34.07	2.88E-03	2.99	11.38	3.49	0.347	0.250	1
329	LO	9,000	34.07	1.48E-05	2.96	11.53	2.20	0.658	0.336	1
330	LO	9,300	35.20	1.98E-05	3.05	11.55	3.55	0.498	0.284	1
331	LO	7,500	28.39	6.55E-06	2.45	11.58	2.95	0.351	0.250	1
332	LO	7,500	28.39	1.78E-05	2.44	11.64	2.94	0.780	0.292	1
333	LO	8,000	30.28	9.95E-04	2.59	11.70	3.09	0.800	0.250	1
334	LO	9,000	34.07	1.51E-02	2.88	11.83	2.90	0.800	0.303	1
335	LO	9,000	34.07	1.51E-02	2.87	11.87	3.37	0.768	0.374	1
336	LO	10,000	37.85	9.60E-04	3.11	12.17	3.61	0.369	0.417	1
337	LO	9,100	34.45	1.46E-03	2.82	12.20	3.32	0.565	0.282	1
338	LO	9,900	37.48	3.03E-03	3.06	12.25	3.56	0.466	0.360	1
339	LO	8,000	30.28	7.52E-05	2.46	12.29	2.96	0.470	0.424	1
340	LO	10,000	37.85	7.82E-05	3.08	12.30	3.58	0.578	0.423	1
341	LO	8,000	30.28	6.79E-05	2.45	12.35	2.95	0.536	0.250	1
342	LO	9,000	34.07	1.48E-05	2.74	12.45	3.24	0.567	0.261	1
343	LO	9,000	34.07	1.51E-02	2.72	12.51	3.22	0.570	0.389	1

(continued)

Table 3B-3. (continued)

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
344	LO	6,850	25.93	5.04E-03	2.07	12.53	2.57	0.579	0.250	1
345	LO	10,000	37.85	1.20E-04	3.01	12.57	3.51	0.758	0.260	1
346	LO	10,000	37.85	4.05E-04	2.99	12.64	3.30	0.297	0.354	1
347	LO	10,000	37.85	4.08E-05	2.98	12.69	3.48	0.234	0.316	1
348	LO	7,680	29.07	2.41E-03	2.27	12.83	2.77	0.463	0.273	1
349	LO	9,000	34.07	2.67E-02	2.62	13.00	3.12	0.477	0.250	1
350	LO	10,000	37.85	1.50E-03	2.91	13.00	3.41	0.719	0.338	1
351	LO	8,000	30.28	9.95E-04	2.32	13.04	2.82	0.578	0.278	1
352	LO	10,000	37.85	4.08E-05	2.88	13.13	3.38	0.710	0.250	1
353	LO	10,000	37.85	2.19E-02	2.86	13.25	3.36	0.204	0.420	1
354	LO	11,000	41.64	3.42E-04	3.14	13.27	3.64	0.510	0.250	1
355	LO	10,000	37.85	6.60E-05	2.85	13.28	3.35	0.384	0.250	1
356	LO	10,885	41.20	2.70E-03	3.09	13.34	3.59	0.427	0.314	1
357	LO	9,000	34.07	1.51E-02	2.55	13.38	3.05	0.372	0.276	1
358	LO	10,000	37.85	4.08E-05	2.79	13.59	3.29	0.577	0.336	1
359	LO	12,000	45.42	1.50E-04	3.33	13.65	3.83	0.466	0.313	1
360	LO	9,000	34.07	1.51E-02	2.49	13.66	2.99	0.438	0.250	1
361	LO	9,300	35.20	1.98E-05	2.56	13.77	0.50	0.750	0.250	1
362	LO	9,000	34.07	7.74E-04	2.47	13.77	2.97	0.442	0.250	1
363	LO	12,000	45.42	2.40E-03	3.28	13.87	3.78	0.592	0.399	1
364	LO	10,000	37.85	9.12E-06	2.72	13.94	3.22	0.408	0.250	1
365	LO	10,000	37.85	7.82E-05	2.69	14.06	3.10	0.772	0.273	1
366	LO	10,000	37.85	1.09E-02	2.68	14.11	3.18	0.708	0.479	1
367	LO	12,800	48.45	3.74E-04	3.40	14.26	3.90	0.553	0.440	1
368	LO	10,000	37.85	4.08E-05	2.65	14.26	3.15	0.527	0.307	1
369	LO	10,000	37.85	9.72E-06	2.65	14.29	3.15	0.564	0.363	1
370	LO	10,000	37.85	9.60E-04	2.64	14.35	3.14	0.550	0.446	1
371	LO	10,000	37.85	9.60E-04	2.63	14.39	3.13	0.707	0.250	1
372	LO	10,000	37.85	4.80E-04	2.61	14.48	3.11	0.315	0.331	1
373	LO	12,600	47.70	1.51E-02	3.24	14.72	3.74	0.617	0.250	1
374	LO	10,000	37.85	1.50E-03	2.57	14.74	3.07	0.690	0.250	1
375	LO	10,000	37.85	3.81E-03	2.56	14.76	3.06	0.515	0.250	1
376	LO	11,000	41.64	3.42E-04	2.80	14.86	3.30	0.631	0.250	1
377	LO	10,000	37.85	5.45E-03	2.52	15.05	3.02	0.200	0.250	1
378	LO	12,000	45.42	5.06E-03	2.99	15.18	3.49	0.279	0.689	1
379	LO	10,640	40.28	2.70E-03	2.65	15.20	3.15	0.648	0.370	1
380	LO	15,000	56.78	1.19E-03	3.72	15.28	4.22	0.645	0.639	1
381	LO	13,400	50.72	2.80E-02	3.31	15.32	3.81	0.685	0.250	1
382	LO	12,000	45.42	1.50E-04	2.96	15.35	3.46	0.459	0.250	1
383	LO	11,360	43.00	2.70E-03	2.79	15.43	3.29	0.700	0.410	1
384	LO	12,000	45.42	5.52E-03	2.91	15.59	3.41	0.367	0.250	1
385	LO	15,000	56.78	4.66E-03	3.62	15.67	3.20	0.476	0.479	1
386	LO	12,500	47.32	1.50E-04	3.02	15.68	3.52	0.662	0.250	1
387	LO	12,800	48.45	3.74E-04	3.08	15.74	3.58	0.279	0.299	1
388	LO	8,000	30.28	1.50E-05	1.92	15.78	2.42	0.321	0.336	1
389	LO	13,500	51.10	8.08E-03	3.21	15.90	3.71	0.689	0.312	1
390	LO	8,700	32.93	1.09E-05	2.07	15.90	2.57	0.225	0.254	1
391	LO	10,000	37.85	4.05E-04	2.34	16.16	2.84	0.615	0.564	1
392	LO	12,000	45.42	6.24E-05	2.81	16.18	3.31	0.325	0.450	1

(continued)

Table 3B-3. (continued)

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
393	LO	12,000	45.42	3.86E-04	2.79	16.27	3.29	0.736	0.359	1
394	LO	11,000	41.64	3.42E-04	2.55	16.36	3.05	0.453	0.340	1
395	LO	8,500	32.18	4.48E-03	1.94	16.57	2.44	0.200	0.250	1
396	LO	12,500	47.32	1.50E-04	2.81	16.84	3.31	0.588	0.513	1
397	LO	12,000	45.42	1.57E-01	2.65	17.17	3.15	0.487	0.284	1
398	LO	12,000	45.42	1.25E-03	2.63	17.24	3.13	0.800	0.506	1
399	LO	12,000	45.42	1.44E-06	2.63	17.24	3.13	0.764	0.342	1
400	LO	11,200	42.40	1.34E-03	2.45	17.31	2.95	0.745	0.399	1
401	LO	11,200	42.40	1.34E-03	2.44	17.39	2.94	0.495	0.250	1
402	LO	12,000	45.42	1.19E-03	2.61	17.39	3.11	0.445	0.347	1
403	LO	10,000	37.85	1.09E-03	2.18	17.40	2.68	0.205	0.250	1
404	LO	15,000	56.78	2.85E-05	3.25	17.46	3.75	0.800	0.551	1
405	LO	12,000	45.42	3.86E-04	2.60	17.47	3.10	0.405	0.387	1
406	LO	12,000	45.42	6.24E-05	2.58	17.59	3.08	0.458	0.357	1
407	LO	11,000	41.64	3.42E-04	2.36	17.68	2.86	0.538	0.286	1
408	LO	15,000	56.78	1.37E-02	3.18	17.88	3.68	0.496	0.464	1
409	LO	15,000	56.78	2.19E-03	3.16	17.96	3.66	0.498	0.264	1
410	LO	11,200	42.40	1.34E-03	2.34	18.09	2.84	0.739	0.373	1
411	LO	11,500	43.53	4.80E-06	2.37	18.36	2.87	0.442	0.250	1
412	LO	14,490	54.85	9.37E-03	2.98	18.41	2.70	0.200	0.691	1
413	LO	13,500	51.10	8.08E-03	2.77	18.44	3.27	0.499	0.343	1
414	LO	12,000	45.42	1.44E-01	2.44	18.61	2.94	0.282	0.329	1
415	LO	16,000	60.57	1.44E-03	3.24	18.68	3.74	0.646	0.250	1
416	LO	12,000	45.42	1.25E-03	2.42	18.78	2.92	0.286	0.250	1
417	LO	14,950	56.59	2.70E-03	3.01	18.79	3.51	0.505	0.608	1
418	LO	12,800	48.45	3.74E-04	2.57	18.83	3.07	0.515	0.379	1
419	LO	13,500	51.10	9.23E-05	2.70	18.90	3.20	0.200	0.351	1
420	LO	15,000	56.78	3.86E-04	2.98	19.03	3.48	0.461	0.349	1
421	LO	13,400	50.72	2.80E-02	2.65	19.14	3.15	0.493	0.389	1
422	LO	15,000	56.78	3.42E-04	2.95	19.27	3.45	0.600	0.411	1
423	LO	14,950	56.59	2.70E-03	2.91	19.43	3.41	0.557	0.648	1
424	LO	13,400	50.72	2.80E-02	2.61	19.43	3.11	0.451	0.312	1
425	LO	15,000	56.78	1.19E-03	2.91	19.51	3.41	0.200	0.620	1
426	LO	13,400	50.72	4.99E-05	2.56	19.84	3.06	0.780	0.250	1
427	LO	15,000	56.78	3.42E-04	2.86	19.85	3.36	0.784	0.400	1
428	LO	14,000	53.00	2.94E-04	2.65	19.96	2.20	0.512	0.289	1
429	LO	12,000	45.42	3.86E-04	2.27	20.03	2.77	0.628	0.455	1
430	LO	15,000	56.78	3.42E-04	2.80	20.29	3.30	0.657	0.544	1
431	LO	15,000	56.78	7.24E-07	2.80	20.29	1.10	0.469	0.452	1
432	LO	15,000	56.78	3.42E-04	2.79	20.35	3.29	0.465	0.513	1
433	LO	13,000	49.21	4.82E-03	2.41	20.43	2.91	0.443	0.310	1
434	LO	20,000	75.71	1.85E-04	3.70	20.44	4.20	0.800	0.399	1
435	LO	12,800	48.45	3.81E-04	2.35	20.66	2.85	0.563	0.349	1
436	LO	15,000	56.78	1.19E-03	2.72	20.88	3.22	0.455	0.372	1
437	LO	15,000	56.78	3.42E-04	2.71	20.94	3.21	0.654	0.260	1
438	LO	17,000	64.35	2.52E-05	3.05	21.11	3.55	0.613	0.404	1
439	LO	20,000	75.71	1.85E-04	3.52	21.53	4.02	0.660	0.781	1
440	LO	20,000	75.71	5.42E-04	3.50	21.66	4.00	0.283	0.581	1
441	LO	15,500	58.67	4.46E-04	2.69	21.80	3.19	0.513	0.609	1

(continued)

Table 3B-3. (continued)

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
442	LO	13,400	50.72	2.80E-02	2.32	21.87	2.82	0.416	0.297	1
443	LO	20,000	75.71	3.60E-05	3.45	21.91	3.95	0.356	0.431	1
444	LO	20,000	75.71	1.14E-04	3.44	22.00	3.94	0.572	0.528	1
445	LO	15,000	56.78	2.26E-05	2.56	22.21	3.06	0.200	0.550	1
446	LO	15,000	56.78	1.50E-05	2.54	22.34	3.04	0.321	0.250	1
447	LO	15,000	56.78	1.19E-03	2.51	22.64	3.01	0.232	0.345	1
448	LO	20,000	75.71	1.14E-04	3.33	22.72	3.83	0.250	0.250	1
449	LO	20,000	75.71	2.06E-01	3.30	22.93	3.80	0.375	0.457	1
450	LO	15,000	56.78	1.50E-03	2.46	23.05	2.96	0.687	0.535	1
451	LO	15,000	56.78	8.15E-04	2.46	23.08	2.96	0.744	0.576	1
452	LO	20,000	75.71	6.24E-03	3.25	23.30	3.75	0.503	0.801	1
453	LO	20,000	75.71	1.85E-04	3.21	23.56	3.71	0.320	0.538	1
454	LO	21,600	81.76	3.00E-04	3.44	23.79	3.94	0.452	0.697	1
455	LO	24,000	90.85	1.80E-05	3.79	23.99	4.29	0.525	0.480	1
456	LO	20,000	75.71	1.06E-03	3.15	24.02	3.65	0.496	0.329	1
457	LO	20,000	75.71	5.42E-04	3.14	24.11	3.64	0.538	0.570	1
458	LO	15,000	56.78	4.66E-03	2.35	24.20	2.85	0.529	0.250	1
459	LO	15,000	56.78	1.50E-04	2.33	24.33	1.70	0.569	0.582	1
460	LO	21,000	79.49	3.02E-07	3.25	24.46	3.75	0.253	0.665	1
461	LO	15,000	56.78	2.23E-05	2.30	24.68	2.80	0.800	0.250	1
462	LO	20,000	75.71	5.04E-03	3.03	24.99	3.53	0.550	0.614	1
463	LO	21,000	79.49	1.44E-03	3.17	25.06	3.20	0.519	0.563	1
464	LO	20,000	75.71	1.85E-04	3.02	25.11	3.52	0.372	0.289	1
465	LO	20,000	75.71	3.60E-05	3.00	25.23	3.50	0.408	0.808	1
466	LO	21,000	79.49	3.02E-07	3.15	25.25	3.65	0.611	0.720	1
467	LO	20,000	75.71	5.04E-03	2.99	25.28	3.49	0.402	0.286	1
468	LO	20,000	75.71	3.79E-05	2.97	25.46	2.30	0.554	0.636	1
469	LO	20,000	75.71	1.06E-03	2.86	26.51	3.36	0.501	0.495	1
470	LO	20,000	75.71	3.57E-04	2.84	26.66	3.34	0.581	0.871	1
471	LO	23,540	89.11	2.70E-03	3.28	27.13	3.78	0.200	0.742	1
472	LO	26,930	101.94	5.06E-06	3.74	27.24	2.50	0.308	1.269	1
473	LO	20,000	75.71	5.04E-03	2.78	27.25	3.28	0.800	0.766	1
474	LO	25,000	94.63	9.00E-04	3.43	27.57	3.93	0.500	0.975	1
475	LO	20,000	75.71	1.14E-04	2.71	27.90	1.10	0.557	0.790	1
476	LO	23,000	87.06	1.46E-02	3.07	28.37	3.57	0.370	0.719	1
477	LO	20,948	79.30	7.32E-05	2.78	28.52	3.28	0.800	0.730	1
478	LO	21,000	79.49	4.48E-03	2.78	28.59	3.28	0.429	0.717	1
479	LO	25,000	94.63	5.46E-03	3.25	29.14	3.75	0.548	1.079	1
480	LO	15,000	56.78	1.78E-05	1.94	29.25	2.44	0.339	0.331	1
481	LO	25,000	94.63	5.96E-02	3.24	29.25	2.80	0.394	0.832	1
482	LO	14,360	54.36	6.79E-03	1.85	29.42	2.35	0.558	0.499	1
483	LO	25,000	94.63	5.46E-03	3.19	29.70	1.50	0.284	0.891	1
484	LO	24,000	90.85	1.46E-02	3.03	29.98	3.53	0.555	0.739	1
485	LO	20,000	75.71	5.42E-04	2.52	30.07	3.02	0.530	0.547	1
486	LO	25,000	94.63	9.00E-04	3.11	30.44	3.61	0.424	0.532	1
487	LO	20,000	75.71	4.80E-06	2.48	30.58	2.98	0.528	0.864	1
488	LO	30,000	113.56	1.09E-05	3.71	30.58	4.21	0.580	1.345	1
489	LO	26,930	101.94	5.06E-06	3.30	30.89	3.80	0.200	0.250	1
490	LO	21,000	79.49	4.50E-04	2.56	31.09	3.06	0.537	0.537	1

(continued)

Table 3B-3. (continued)

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
491	LO	20,000	75.71	5.42E-04	2.34	32.29	2.84	0.739	0.649	1
492	LO	20,000	75.71	3.79E-05	2.34	32.32	2.84	0.567	0.446	1
493	LO	26,000	98.42	1.87E-03	2.96	33.28	0.50	0.541	0.641	1
494	LO	30,000	113.56	4.65E-04	3.40	33.42	3.90	0.546	1.330	1
495	LO	25,000	94.63	2.87E-03	2.83	33.49	3.33	0.650	0.895	1
496	LO	26,000	98.42	1.86E-05	2.92	33.71	3.42	0.421	0.452	1
497	LO	26,930	101.94	5.06E-06	3.02	33.80	1.90	0.327	0.660	1
498	LO	22,000	83.28	1.36E-03	2.46	33.90	2.96	0.800	0.630	1
499	LO	35,000	132.49	5.51E-05	3.81	34.77	4.31	0.432	0.910	1
500	LO	25,000	94.63	9.00E-04	2.71	34.95	3.21	0.751	0.492	1
501	LO	26,930	101.94	5.06E-06	2.91	35.05	3.41	0.800	1.295	1
502	LO	28,000	105.99	3.23E-03	3.01	35.21	3.51	0.436	1.147	1
503	LO	33,000	124.92	1.07E-01	3.53	35.41	4.03	0.554	1.352	1
504	LO	29,000	109.78	5.04E-03	3.08	35.66	3.58	0.597	0.933	1
505	LO	20,000	75.71	1.30E-05	2.11	35.83	2.61	0.527	0.804	1
506	LO	34,000	128.70	9.26E-04	3.51	36.72	4.01	0.478	0.729	1
507	LO	33,000	124.92	2.25E-03	3.32	37.64	3.82	0.518	1.312	1
508	LO	37,300	141.20	5.57E-06	3.74	37.77	4.24	0.359	1.200	1
509	LO	21,200	80.25	5.14E-03	2.12	37.77	2.62	0.598	0.688	1
510	LO	25,000	94.63	2.87E-03	2.47	38.30	2.97	0.388	1.021	1
511	LO	28,000	105.99	1.06E-03	2.74	38.65	3.24	0.652	1.054	1
512	LO	34,000	128.70	3.86E-06	3.33	38.67	3.83	0.584	1.395	1
513	LO	35,000	132.49	4.66E-05	3.42	38.74	1.20	0.272	1.142	1
514	LO	30,000	113.56	3.84E-03	2.93	38.76	3.43	0.468	0.721	1
515	LO	26,930	101.94	5.06E-06	2.62	38.89	3.12	0.524	1.169	1
516	LO	26,930	101.94	5.06E-06	2.60	39.27	1.40	0.800	0.909	1
517	LO	24,300	91.99	1.44E-06	2.31	39.85	2.81	0.784	0.589	1
518	LO	35,000	132.49	2.49E-03	3.28	40.39	3.78	0.541	0.793	1
519	LO	25,000	94.63	9.00E-04	2.34	40.47	2.84	0.473	0.788	1
520	LO	36,000	136.27	1.80E-05	3.34	40.84	0.50	0.293	1.847	1
521	LO	40,000	151.42	7.64E-05	3.69	41.00	0.50	0.204	1.180	1
522	LO	37,300	141.20	5.57E-06	3.43	41.18	3.93	0.495	1.070	1
523	LO	41,000	155.20	2.79E-03	3.75	41.36	4.25	0.705	1.458	1
524	LO	41,000	155.20	2.28E-03	3.72	41.70	4.22	0.449	1.925	1
525	LO	40,000	151.42	2.96E-02	3.61	41.92	4.11	0.358	0.988	1
526	LO	40,465	153.18	6.76E-03	3.49	43.89	3.99	0.523	1.385	1
527	LO	40,000	151.42	2.16E-05	3.40	44.50	3.90	0.389	1.925	1
528	LO	40,933	154.95	2.57E-01	3.46	44.79	3.96	0.684	1.428	1
529	LO	50,000	189.27	7.44E-04	4.12	45.96	4.62	0.403	1.820	1
530	LO	30,000	113.56	7.20E-03	2.46	46.12	2.96	0.691	0.836	1
531	LO	40,000	151.42	2.87E-05	3.28	46.20	3.78	0.453	1.625	1
532	LO	40,000	151.42	2.96E-02	3.27	46.24	3.77	0.200	0.560	1
533	LO	37,000	140.06	1.07E-01	3.01	46.55	3.51	0.458	1.599	1
534	LO	47,300	179.05	2.05E-03	3.80	47.10	4.30	0.641	1.775	1
535	LO	41,000	155.20	2.79E-03	3.17	48.95	3.67	0.307	1.204	1
536	LO	37,300	141.20	5.57E-06	2.88	49.00	3.38	0.626	0.906	1
537	LO	46,000	174.13	2.28E-03	3.55	49.04	1.30	0.598	0.788	1
538	LO	41,000	155.20	2.79E-03	3.11	49.97	3.61	0.640	1.530	1
539	LO	47,000	177.91	1.07E-01	3.50	50.79	0.90	0.449	1.674	1

(continued)

Table 3B-3. (continued)

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
540	LO	48,600	183.97	6.67E-04	3.60	51.09	4.10	0.650	1.772	1
541	LO	55,000	208.20	7.08E-03	4.00	52.08	4.50	0.616	1.779	1
542	LO	46,000	174.13	2.41E-03	3.33	52.31	3.83	0.720	1.205	1
543	LO	40,000	151.42	7.64E-05	2.87	52.78	3.37	0.630	1.196	1
544	LO	40,000	151.42	2.96E-02	2.87	52.81	3.37	0.440	1.743	1
545	LO	54,000	204.41	1.63E-02	3.84	53.20	4.34	0.710	0.761	1
546	LO	55,000	208.20	2.72E-03	3.85	54.11	4.35	0.389	1.328	1
547	LO	55,000	208.20	2.72E-03	3.83	54.38	4.33	0.697	1.706	1
548	LO	50,000	189.27	2.68E-02	3.46	54.70	3.96	0.442	1.064	1
549	LO	55,000	208.20	2.81E-03	3.78	55.14	4.28	0.492	1.905	1
550	LO	37,300	141.20	5.57E-06	2.56	55.18	3.06	0.200	1.039	1
551	LO	61,500	232.80	1.34E-03	4.17	55.84	4.67	0.344	2.283	1
552	LO	55,000	208.20	2.81E-03	3.72	55.97	4.22	0.402	2.169	1
553	LO	57,000	215.77	2.24E-02	3.81	56.61	4.31	0.562	1.701	1
554	LO	50,000	189.27	4.80E-04	3.31	57.10	3.81	0.290	1.585	1
555	LO	61,500	232.80	1.34E-03	3.98	58.50	4.48	0.800	1.552	1
556	LO	48,500	183.59	4.50E-04	3.08	59.61	3.58	0.800	1.670	1
557	LO	50,000	189.27	4.02E-02	3.08	61.37	3.58	0.800	1.387	1
558	LO	50,000	189.27	2.72E-02	3.05	62.01	3.55	0.361	1.073	1
559	LO	61,500	232.80	1.34E-03	3.65	63.70	4.15	0.498	1.344	1
560	LO	50,000	189.27	8.77E-05	2.96	63.90	3.46	0.626	2.093	1
561	LO	48,500	183.59	4.50E-04	2.82	65.11	3.10	0.640	2.705	1
562	LO	67,000	253.62	5.80E-03	3.69	68.79	0.90	0.249	2.977	1
563	LO	65,000	246.05	7.84E-06	3.53	69.77	1.10	0.200	1.722	1
564	LO	65,000	246.05	1.05E-02	3.51	70.17	4.01	0.229	2.586	1
565	LO	46,000	174.13	5.04E-04	2.44	71.34	2.30	0.385	1.307	1
566	LO	48,000	181.70	3.47E-03	2.51	72.51	3.01	0.342	1.253	1
567	LO	80,000	302.83	5.04E-03	4.11	73.67	3.70	0.378	3.230	1
568	LO	80,000	302.83	5.04E-03	3.92	77.17	4.42	0.633	1.738	1
569	LO	55,000	208.20	2.81E-03	2.66	78.37	3.16	0.800	1.723	1
570	LO	65,000	246.05	7.84E-06	3.13	78.53	3.63	0.406	2.017	1
571	LO	80,000	302.83	8.07E-03	3.79	79.95	4.29	0.533	3.450	1
572	LO	80,000	302.83	5.04E-03	3.65	82.88	1.00	0.612	3.799	1
573	LO	75,830	287.05	4.37E-03	3.41	84.11	3.91	0.479	2.570	1
574	LO	72,000	272.55	2.42E-05	3.14	86.88	3.64	0.354	0.473	1
575	LO	100,000	378.54	2.89E-04	4.30	88.03	4.80	0.297	2.237	1
576	LO	87,000	329.33	1.07E-01	3.57	92.35	0.60	0.574	1.206	1
577	LO	125,000	473.17	3.00E-03	4.70	100.68	5.20	0.781	4.376	1
578	LO	117,800	445.92	9.02E-04	4.32	103.30	4.82	0.505	4.034	1
579	LO	120,000	454.25	4.96E-03	4.36	104.29	2.90	0.289	2.480	1
580	LO	80,000	302.83	8.07E-03	2.89	104.65	2.90	0.259	2.951	1
581	LO	92,400	349.77	3.22E-03	3.22	108.70	3.72	0.781	3.220	1
582	LO	120,000	454.25	7.20E-05	4.13	110.05	4.63	0.200	3.337	1
583	LO	92,400	349.77	3.22E-03	3.17	110.23	3.67	0.711	2.796	1
584	LO	120,000	454.25	7.56E-03	4.01	113.18	0.50	0.385	3.602	1
585	LO	100,000	378.54	2.89E-04	3.31	114.29	3.80	0.401	3.772	1
586	LO	119,700	453.11	1.51E-02	3.77	120.17	4.27	0.553	3.545	1
587	LO	100,000	378.54	2.68E-02	3.10	122.12	3.60	0.504	3.415	1
588	LO	110,000	416.39	1.89E-02	3.40	122.59	3.90	0.550	3.623	1

(continued)

Table 3B-3. (continued)

Tank Index	Aeration Level	Size (gal)	Capacity (m^3)	Through-put (m^3/s)	Depth (m)	Surface Area (m^2)	Source Height (m)	Fraction Aerated	Total Aerator Horse-power	Number of Impellers/ Aerators
ATIndex				Q_wmu	d_wmu	SrcArea	SHight	F_aer	Powr	n_imp
589	LO	119,700	453.11	1.51E-02	3.59	126.25	4.09	0.358	2.031	1
590	LO	103,600	392.17	1.05E-02	3.06	128.25	3.56	0.598	3.176	1
591	LO	150,000	567.81	1.55E-03	3.96	143.23	4.46	0.391	4.456	1
592	LO	200,000	757.08	4.71E-01	4.70	161.09	5.20	0.326	2.832	1
593	LO	210,000	794.93	1.89E-02	4.88	162.74	4.30	0.678	5.052	1
594	LO	200,000	757.08	4.71E-01	4.61	164.14	5.00	0.404	9.990	1
595	LO	225,000	851.71	2.86E-04	4.88	174.58	5.38	0.674	6.577	1
596	LO	200,000	757.08	4.71E-01	4.30	176.20	4.80	0.757	2.150	1
597	LO	135,000	511.03	2.68E-02	2.74	186.84	3.24	0.469	2.278	1
598	LO	250,000	946.35	4.88E-05	4.71	200.88	5.21	0.437	5.826	1
599	LO	250,000	946.35	4.88E-05	4.67	202.57	5.17	0.586	4.592	1
600	LO	250,000	946.35	2.44E-02	4.58	206.53	3.00	0.585	5.402	1
601	LO	187,000	707.87	8.64E-02	3.36	210.47	2.20	0.670	1.963	1
602	LO	300,000	1,135.62	2.67E-02	4.87	233.15	5.37	0.601	4.749	1
603	LO	250,000	946.35	4.88E-05	3.98	238.02	4.48	0.606	8.768	1
604	LO	320,000	1,211.33	6.00E-04	4.68	258.69	1.50	0.354	7.695	1
605	LO	300,000	1,135.62	8.17E-04	4.31	263.38	4.81	0.513	12.948	1
606	LO	320,000	1,211.33	6.07E-04	4.38	276.61	2.80	0.466	11.313	1
607	LO	420,000	1,589.87	1.07E-01	5.74	276.85	6.24	0.551	8.451	1
608	LO	312,000	1,181.04	1.45E-03	4.25	278.17	4.75	0.315	14.275	1
609	LO	395,300	1,496.37	6.96E-04	5.29	282.79	5.79	0.559	9.977	1
610	LO	395,300	1,496.37	6.96E-04	5.15	290.36	5.65	0.420	14.353	1
611	LO	320,000	1,211.33	6.07E-04	4.12	294.27	4.62	0.794	8.523	1
612	LO	450,000	1,703.43	6.15E-03	5.23	325.81	5.73	0.665	10.896	1
613	LO	415,000	1,570.94	1.86E-03	4.74	331.54	4.50	0.200	6.073	1
614	LO	460,000	1,741.28	1.07E-01	4.89	355.95	5.39	0.717	17.351	1
615	LO	543,300	2,056.61	6.26E-03	5.30	388.02	5.80	0.648	7.178	1
616	LO	500,000	1,892.70	5.40E-02	4.59	412.37	5.09	0.638	11.484	1
617	LO	900,000	3,406.86	3.18E-05	5.73	594.96	6.23	0.200	21.511	1
618	LO	543,300	2,056.61	6.26E-03	3.46	595.02	3.96	0.692	11.471	1
619	LO	900,000	3,406.86	2.72E-02	4.51	755.52	5.01	0.567	9.136	1
620	LO	1,500,000	5,678.10	2.03E-02	6.29	902.31	0.50	0.380	24.253	2
621	LO	1,500,000	5,678.10	8.35E-03	5.51	1,031.00	6.01	0.648	39.801	2
622	LO	1,500,000	5,678.10	2.03E-02	5.13	1,107.74	5.63	0.330	35.589	1
623	LO	3,000,000	11,356.19	4.02E-02	6.18	1,837.68	6.68	0.744	55.158	1
624	LO	6,720,000	25,437.88	2.36E-03	7.03	3,616.24	1.10	0.200	183.260	2

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